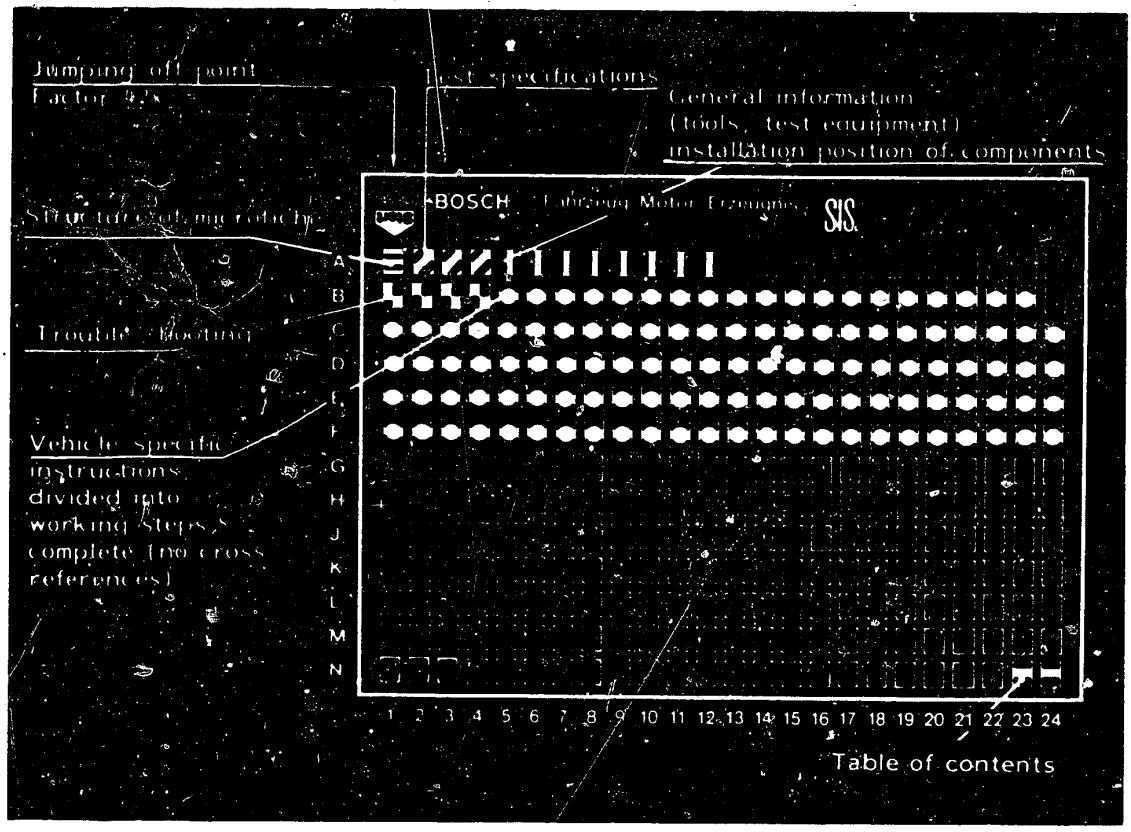
Structure of microfiche



1. Read from left to right

2. Title of microfiche (appears on each coordinate)

E16	Product/component/test step Vehicle/engine

Coordinate

3. Limits of section

Beginning	Mid-section	End	One-page section

4. Purely vehicle-specific passages in the text are marked with a vertical bar.

5. Reference to relevant working steps in the test specifications, e.g. coordinate C6.

C6

A1 Trouble-shooting program

1. Test specifications

1.1 Idle speed:	750 ± 50 min^{-1}	C10
1.2 Nozzle-opening pressure:	130 + 8 bar	C11
1.3 Filter test max. allowable differential pressure:	0.3 bar	C15
1.4 Compression loss:	Max. 25%	D5
1.5 Injection timing: Engine position:	Cyl. 1 at TDC	F8

Checking value

Pump position: 0.95...0.99 mm ABDC (9.78 - 11.82)
Pump position: 0.78...0.82 mm ABDC (12.82 →)

Setting values

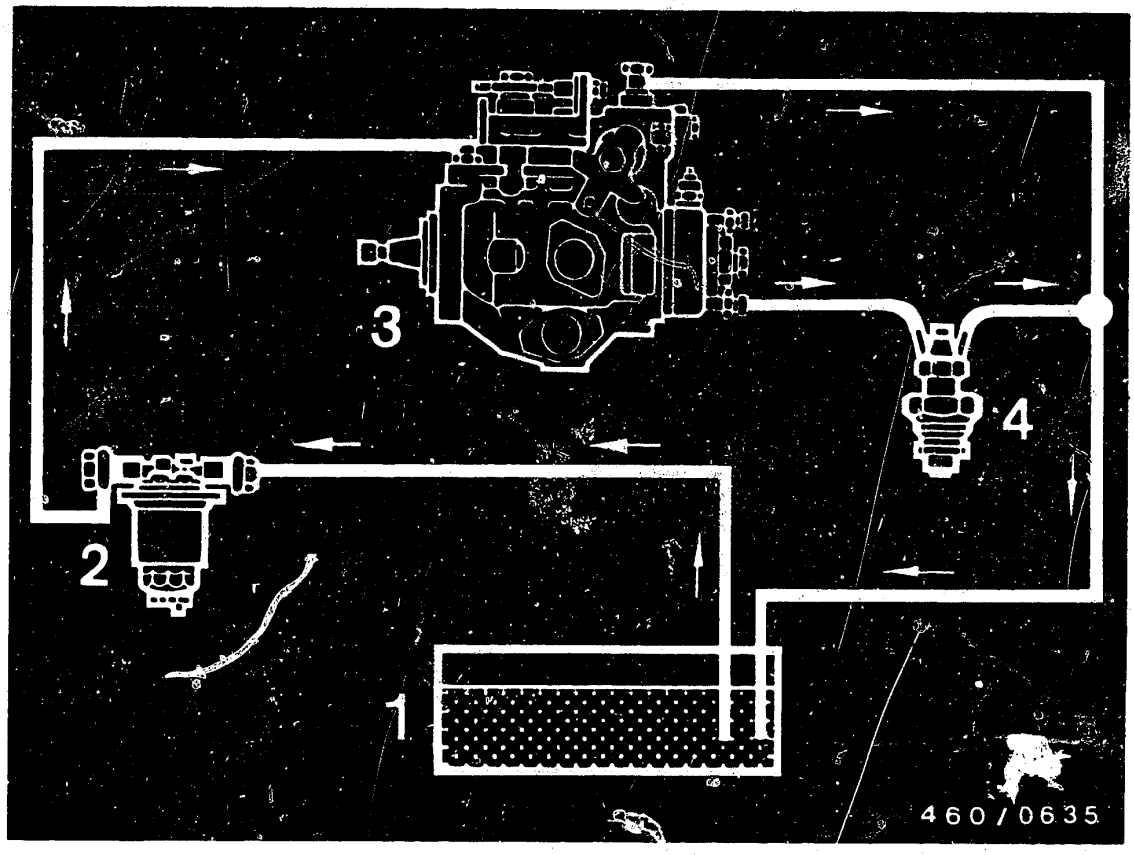
Pump position: 0.97 mm ABDC (9.78 - 11.82)
Pump position: 0.80 mm ABDC (12.82 →)

1.6 Compression pressure:	28...34 bar
Allowable difference between cylinders:	Max. 5 bar

1.7 Toothed-belt tension: Scale value 12...13

1.8 Tightening torques

Injection-pump gear (hexagon nut)	45 Nm
Fuel lines	25 Nm
Injection-pump fastening screws	25 Nm
Camshaft gear	100 Nm
Screw plug	15 Nm
Nozzle-holder assembly fastening screws	70 Nm
Sheathed-element glow plugs	40 Nm
Camshaft drive gear (hexagon screw)	45 Nm
Injection-pump support bracket (fastening screws)	25 Nm
Injection-pump bracket	65 Nm

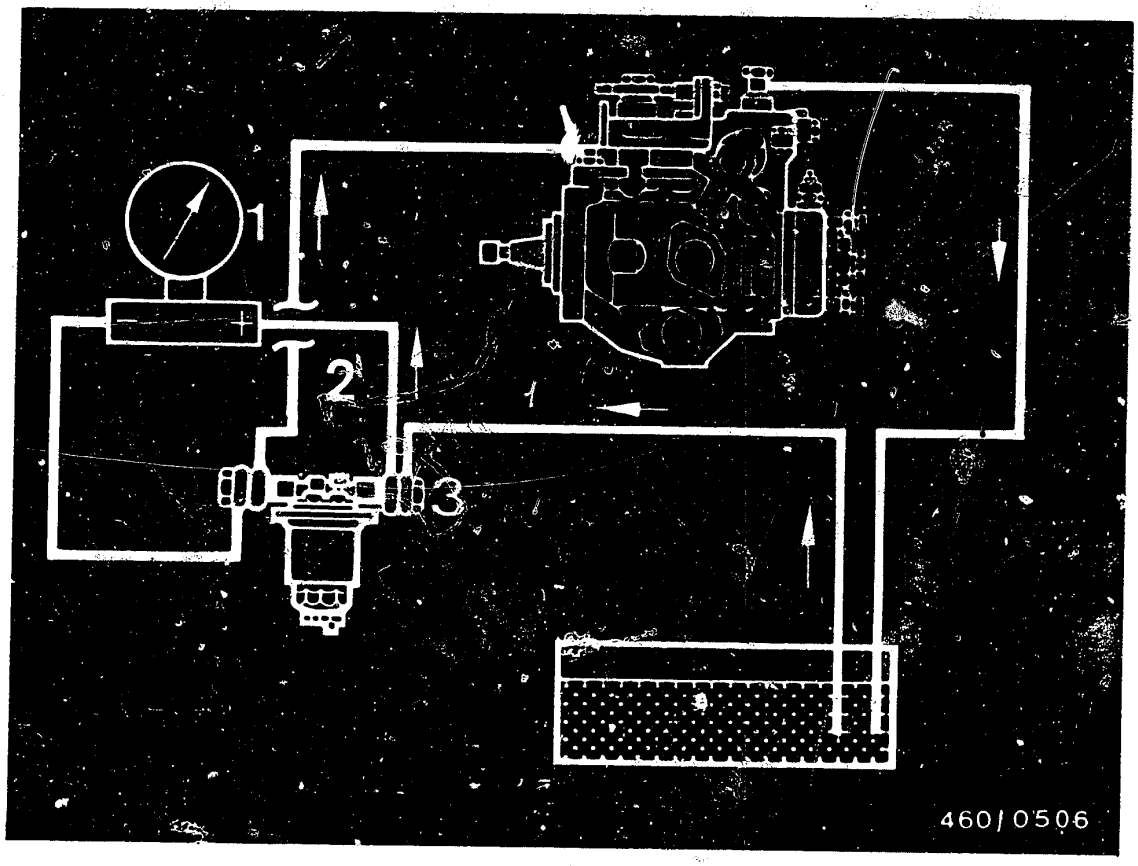


1 = Fuel tank
2 = Fuel filter
3 = Distributer-type injection pump
4 = Injection nozzles

2. Diagram of fuel lines

The fuel lines are connected in accordance with the above diagram.

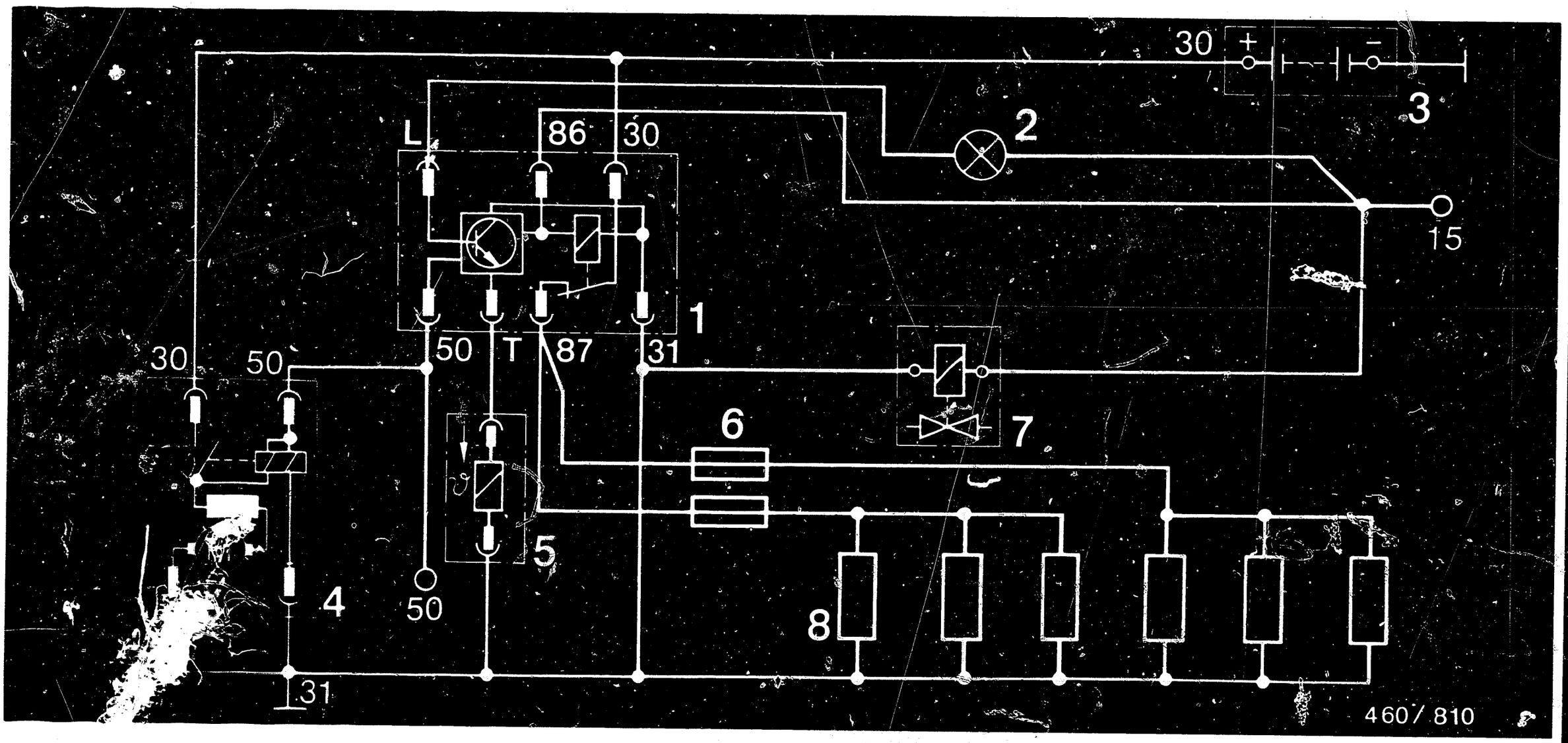
The fuel flows in the direction of the arrows.



1 = Differential-pressure gauge
2 = Filter outlet (use inlet union and extra-long inlet-union screw 2 443 456 020)
3 = Filter inlet (use inlet union and extra-long inlet-union screw 2 443 456 020)

2.1 Connection diagram for filter test

Connect differential-pressure gauge to fuel filter using appropriate connecting pieces.



1 = Glow-duration unit
2 = Glow-plug indicator lamp
3 = Battery
4 = Starting motor
5 = Temperature sensor
6 = Fuses 80 A
7 = Solenoid-operated valve
8 = Glow plugs

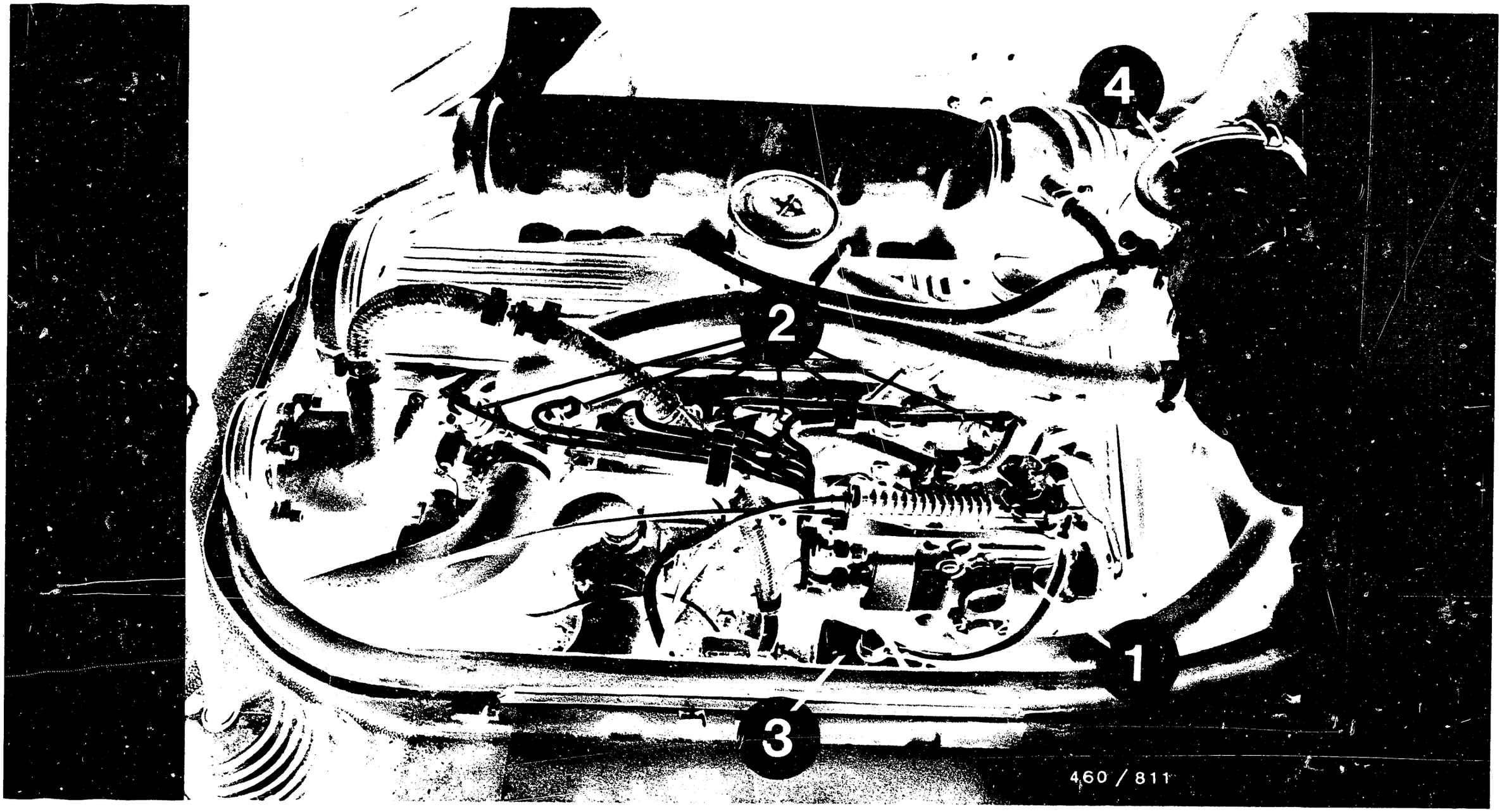
3. Terminal diagram for preheating system

4. Test equipment and tools

Designation	Part No.	Use
Puller	KDEP 1118	Removing injection-pump gear
Locating mandrel	KDEP 1122	Locking the injection-pump gear
Holder	KDEP 1116	For locking the camshaft gear
Toothed-belt tester	KDEP 1121	Testing tension of toothed belt
Setting rule	KDEP 1117	Locating the camshaft
Box wrench	KDEP 1115	Loosening/tightening fuel-injection tubing
Measuring tool	KDEP 1085	Injection timing
Mini dial indicator 1/100 mm divisions	Commercially available e.g. Hahn & Kolb 7000 Stuttgart Part No. 33 003 with adapter KDEP 1127	Injection timing

Test equipment and tools (continued)

Designation	Part No.	Use
Nozzle tester	EFEP 60 H 0 681 200 502	Testing the injection nozzles
Compression tester	Commercially available	Testing the engine compression
Compression-loss tester	EFAW 210 A 0 681 001 901	Testing the engine compression loss
Tachometer	Commercially available	Setting the engine speed
Differential-pressure guage	Commercially available Part No. NG 160/311-911/ - 1.0 + 4.0 bar Firma Henni Nauheimerstr. 78-80 7000 Stuttgart 50	Filter test
Smokemeter Accessories box with metering pump	0 684 102 050 0 681 169 038	Smoke test



5. Installation position of components on VW LT-D (9.78 →)

1 = Injection pump 2 = Injection nozzles 3 = Fuel filter 4 = Air filter

A10 Installation position of components VW-LT 2.4 l diesel →

A11 Installation position of components VW-LT 2.4 . diesel ←

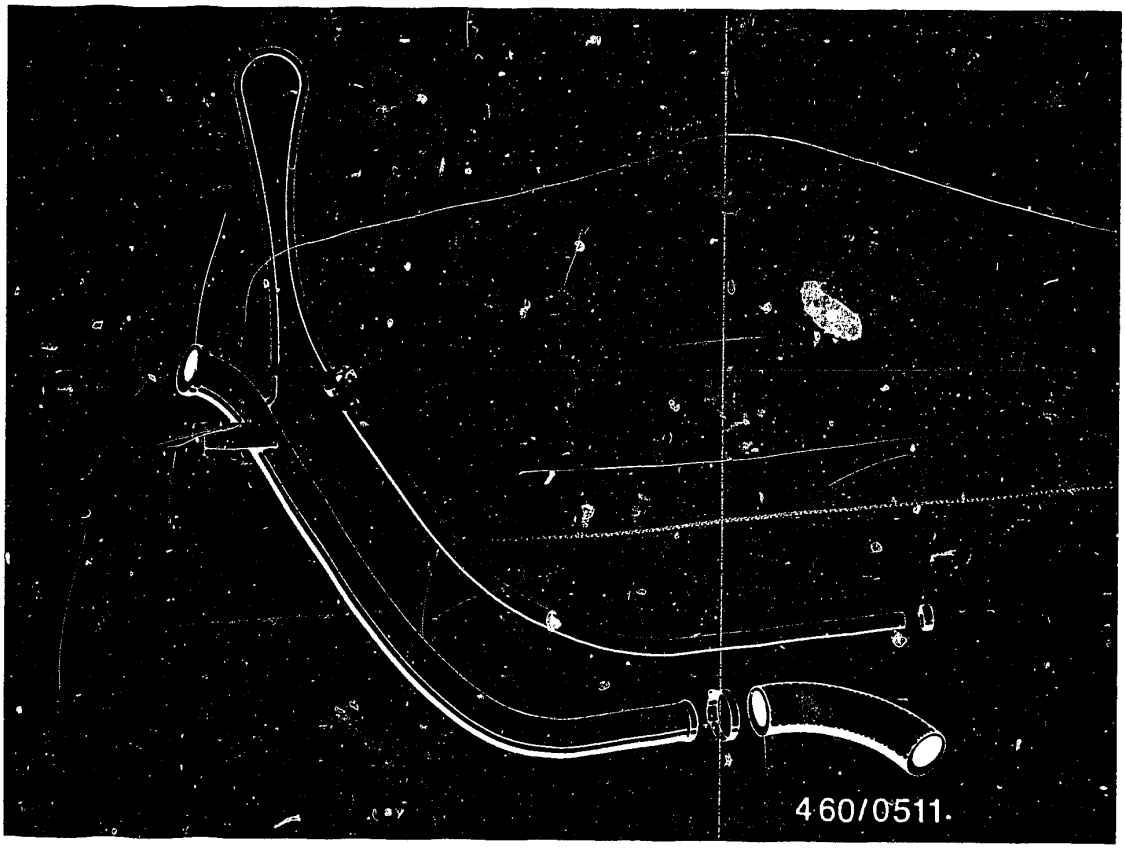
6. Trouble-shooting

Customer complaint (symptom)

1. Engine fails to start or starts only with great difficulty when warm.	2. Engine fails to start or starts only with great difficulty when cold.	3. Engine hunts when idling.	4. Erratic idling when engine is warm.	5. Engine misses during vehicle operation.	6. Unsatisfactory performance.	Cause (component fault)	Coordinate
●	●			●	●	Tank empty; tank vent clogged	B 5
	●					Cold-start accelerator not actuated	B 6
	●		●			Injection sequence does not correspond to firing sequence	B 7
				●		Overflow restriction clogged	B 8
●	●					Shutoff device defective	B 9
		●		●	●	Inlet-union screws of inlet and return lines clogged	B 8
●	●		●	●	●	Air in fuel system	B 15
	●					Heavy paraffin deposits in filter	B 18
●	●			●	●	Connections loose; lines leaky or broken	B 22
●	●			●	●	Supply lines clogged	B 24
●	●			●	●	Fuel-injection tubing clogged or constricted	B 24
					●	Engine air filter clogged	C 1
			●			Idle speed incorrect	C 10
●	●		●		●	Injection nozzle defective	C 11
	●		●		●	Start of pump delivery incorrect	F 8
●	●			●	●	Fuel filter clogged	C 15
	●					Pre-heating system defective	C 18
					●	Timing device defective	D 4
	●		●			Engine compression poor or uneven	D 5
					●	Maximum speed incorrectly adjusted	D 15
●	●	●	●	●	●	Fuel-injection pump (governor) defective or out of adjustment	D 15

Trouble-shooting (continued)

7. Excessive fuel consumption.	8. Engine cannot be switched off.	9. Engine runs rough, black smoke in full-load range; possibly lack of power.	10. Fog-like smoke in full-load range (white).	11. Incorrect engine speeds.	12. Engine will not rev up when cold.	13. Distributor-type fuel-injection pump becomes too hot.	Cause (component fault)	Coordinate
			●		●		Tank empty; tank vent clogged	B 5
					●		Cold-start accelerator not actuated	B 6
		●		●	●		Injection sequence does not correspond to firing sequence	B 7
						●	Overflow restriction clogged	B 8
	●						Shutoff device defective	B 9
			●	●	●		Inlet-union screws of inlet and return lines clogged	B 15
			●		●		Air in fuel system	B 15
					●		Heavy paraffin deposits in filter	B 18
●							Connections loose; lines leaky or broken	B 22
			●		●		Supply lines clogged	B 24
			●		●		Fuel-injection tubing clogged or constricted	B 24
		●					Engine air filter clogged	C 1
				●			Idle speed incorrect	C 10
		●					Injection nozzle defective	C 11
●		●	●		●		Start of pump delivery incorrect	F 8
			●		●		Fuel filter clogged	C 15
							Pre-heating system defective	C 18
		●	●				Timing device defective	D 4
●					●		Engine compression poor or uneven	D 5
				●			Maximum speed incorrectly adjusted	D 15
●	●	●	●	●	●	●	Fuel-injection pump (governor) defective or out of adjustment	D 15



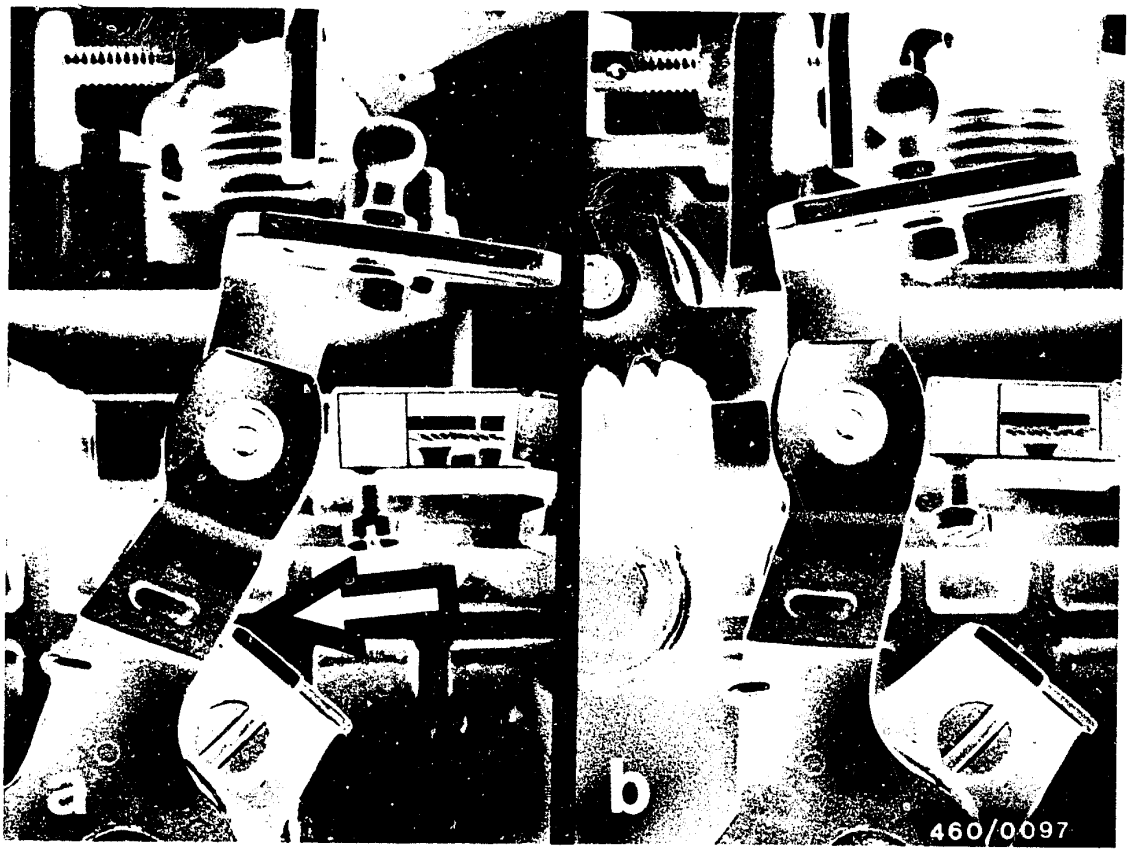
7. Check tank vent

Open tank filler cap.

If the fault disappears after opening the filler cap, the tank vent is defective.

Remove tank-vent hose lines (picture) and check for clogging or constriction.

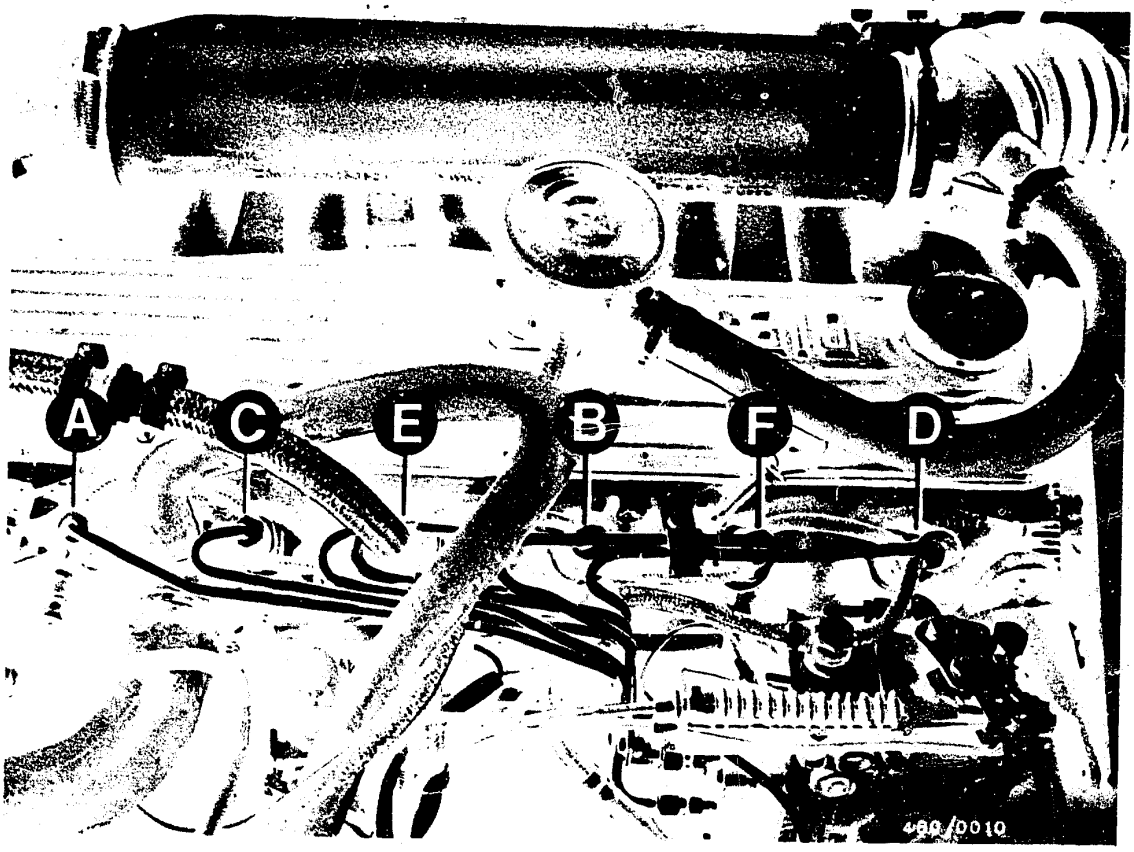
If necessary, check fitting on tank.



8. Test operation of temperature-controlled cold-start accelerator

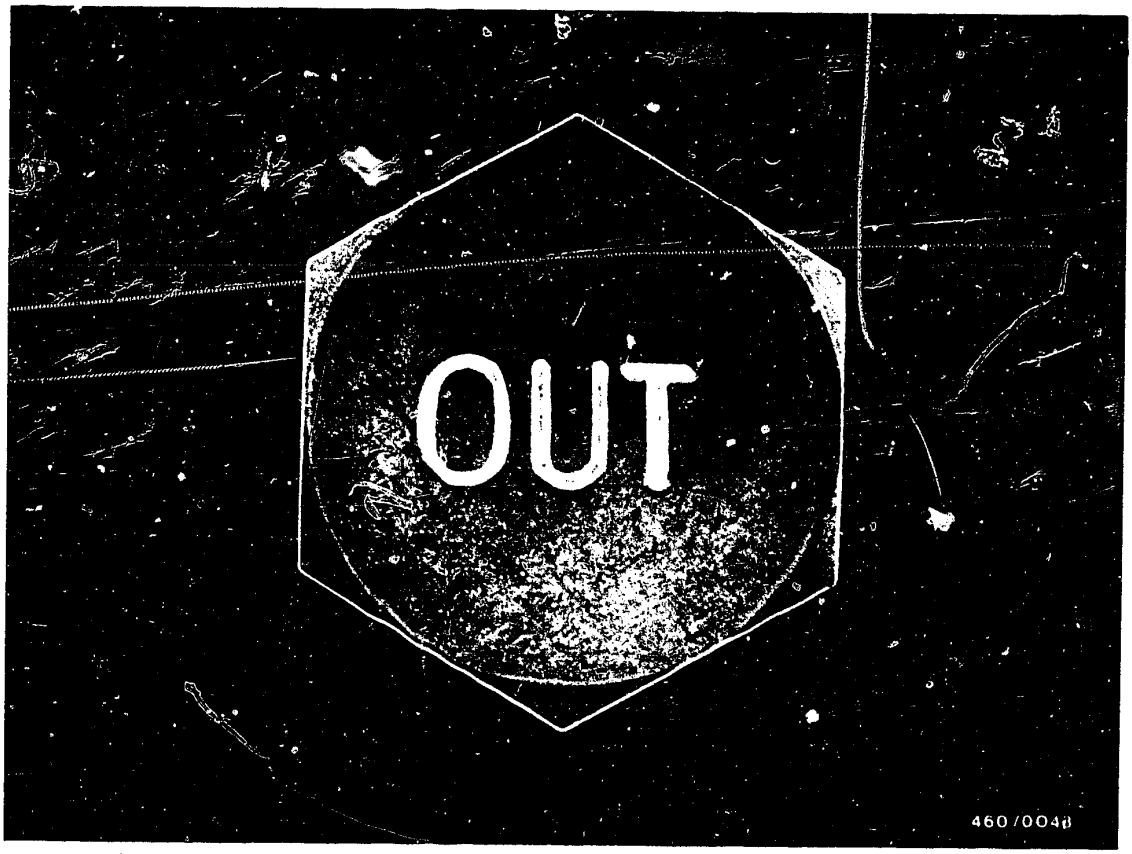
If the cold-start accelerator is correctly set, with the engine at normal operating temperature (coolant temperature approx. 80°C) the control lever of the cold-start accelerator must be up against the stop bracket (picture a - arrow).

When the engine is cold, the control lever of the cold-start accelerator has reached its maximum working stroke (picture b).
If, when cold, the control lever remains up against the stop bracket or makes only a short stroke, it is necessary to remove and reset the injection pump.



9. Check routing of fuel-injection tubing

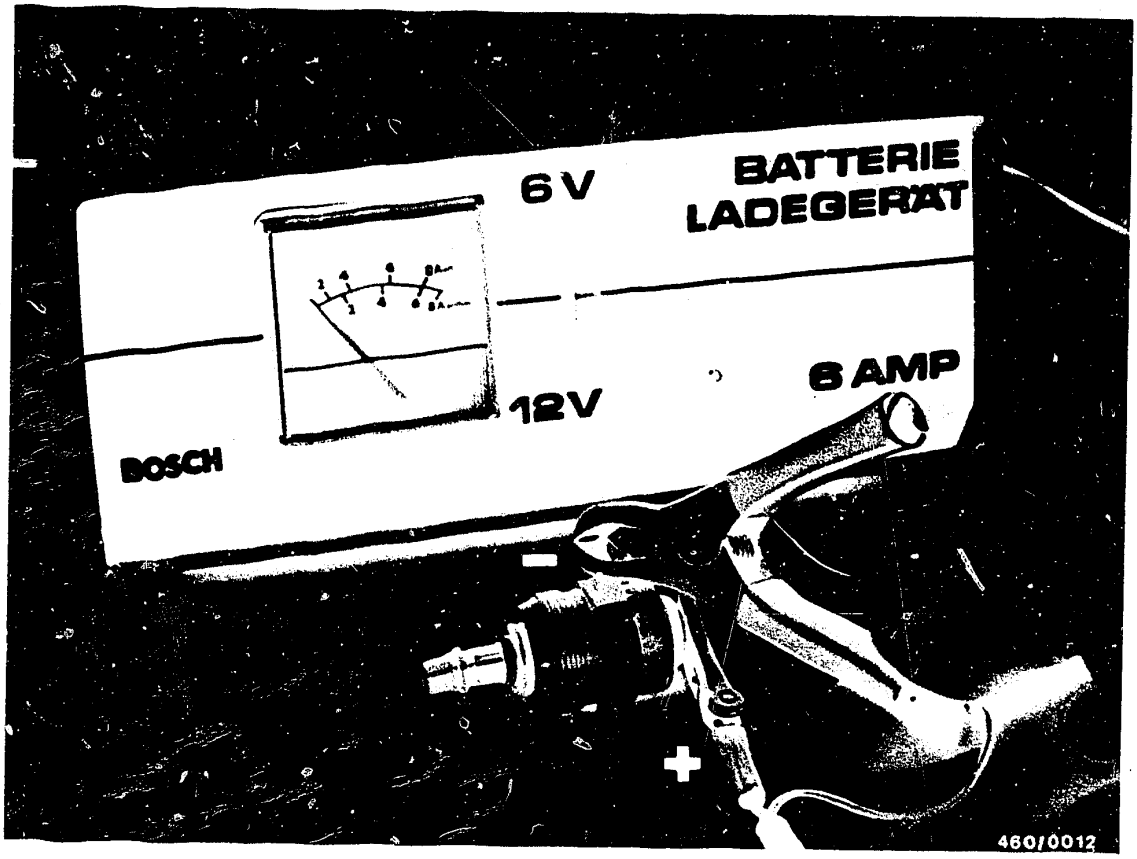
The individual fuel-injection lines are held together by clamps so that it is impossible for the outlets to be mixed up. If, however, there is any doubt, check the routing of the lines as shown in the picture above. The pairing of the fuel-injection pump outlets with the individual engine cylinders is identified by the letters A - F.



10. Check overflow restriction

Unscrew overflow restriction on fuel-injection pump (marked "out").

Perform visual inspection of wire screen for impurities. If in doubt, replace overflow restriction.



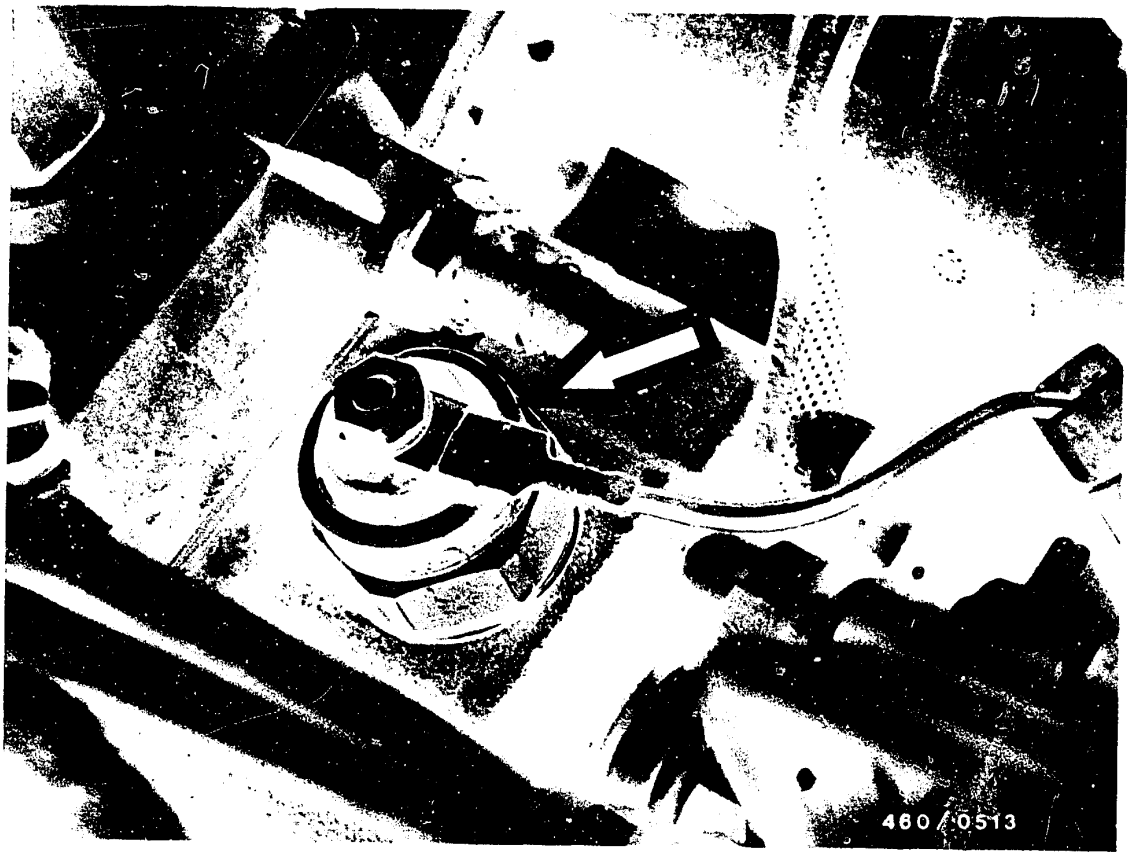
11. Check operation of shutoff device

11.1 Engine fails to start

Check whether solenoid-operated valve is supplied with voltage (min. 10 V) with glow-plug and starter switch switched on (drive position).
If voltage is present, remove fuel-injection tubing and take out solenoid-operated valve.
Cleanliness is essential.

When removed, check operation of solenoid-operated valve.

Note:
When removed, the solenoid-operated valve must only be supplied with voltage for a short period of time since it is no longer being cooled by the fuel.



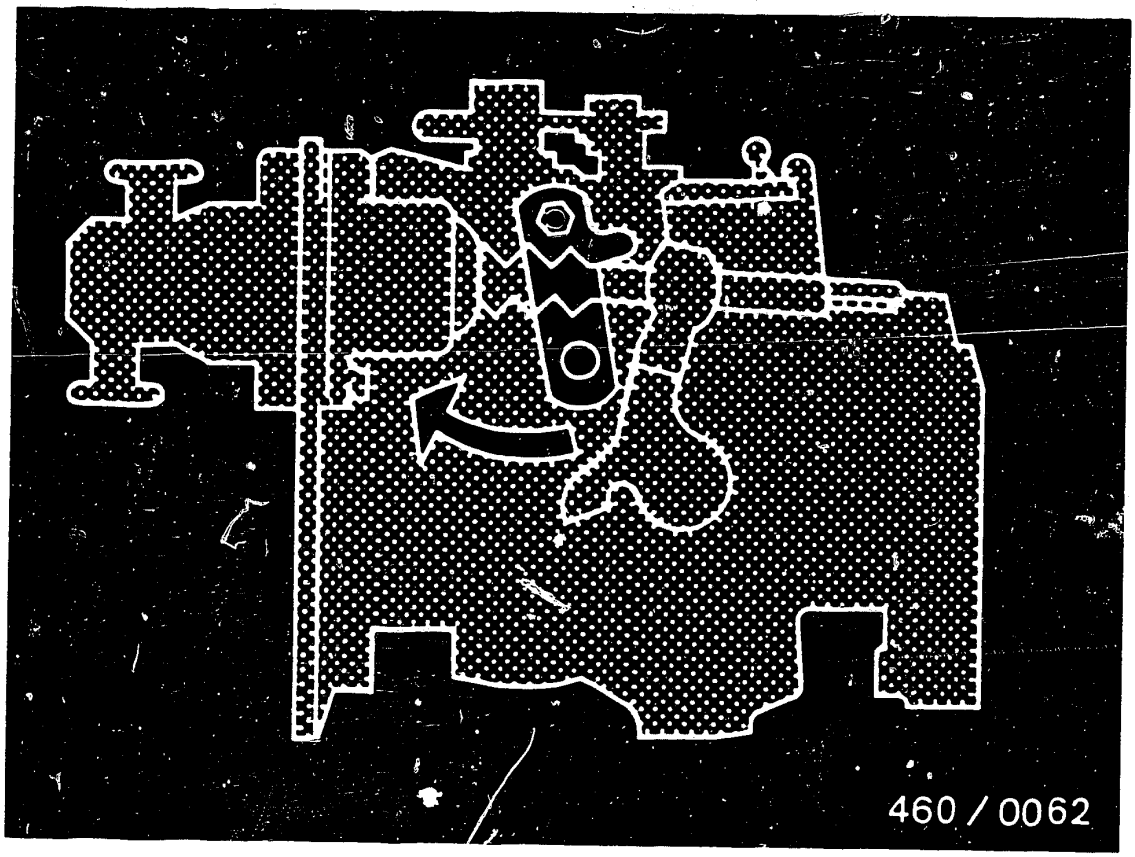
11.2 Engine cannot be stopped

With the glow-plug and starter switch in the stop position, there must be no voltage across the solenoid-operated valve (arrow), i. e. the fuel inlet at the distributor-pump plunger is interrupted.

If the engine continues to run, although there is no voltage across the solenoid-operated valve, the engine can be stopped as follows:

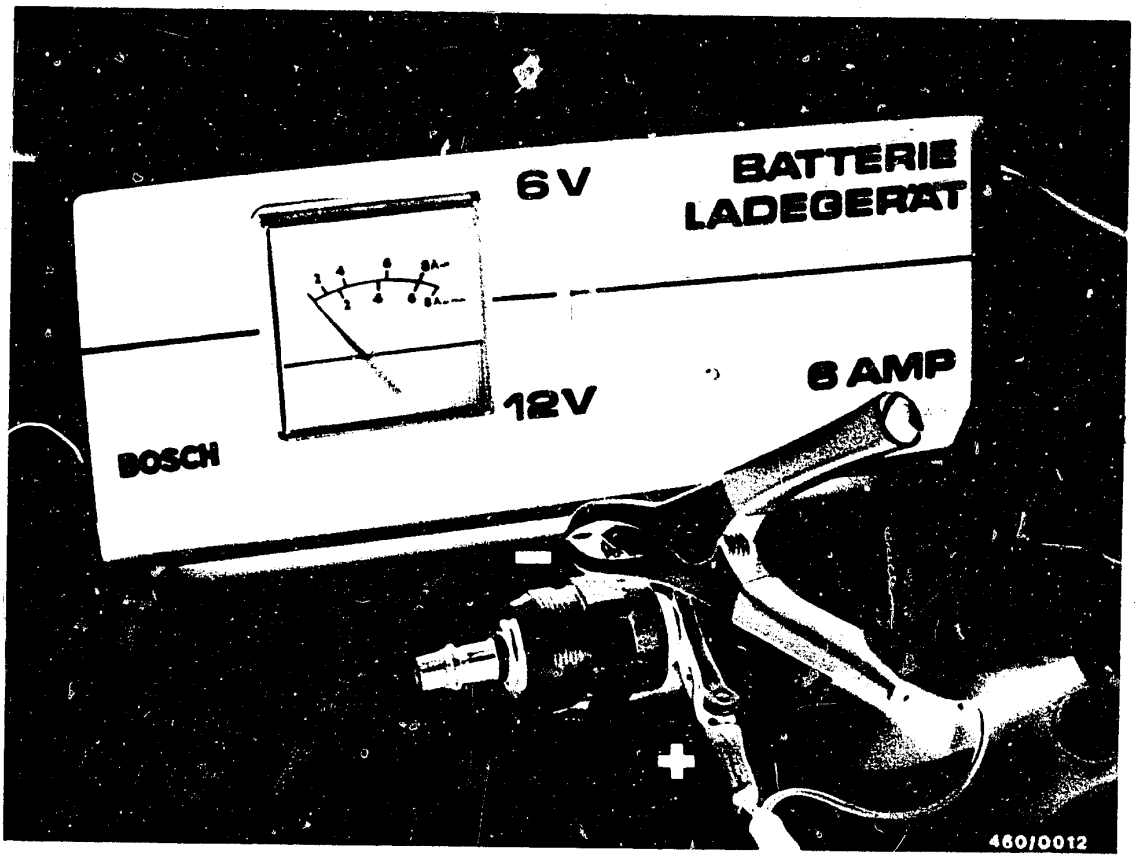
- Vehicles with manually-shifted transmission

Select 3rd or 4th gear.
Depress the foot brake with full force and let out the clutch.



• Vehicles with automatic transmission

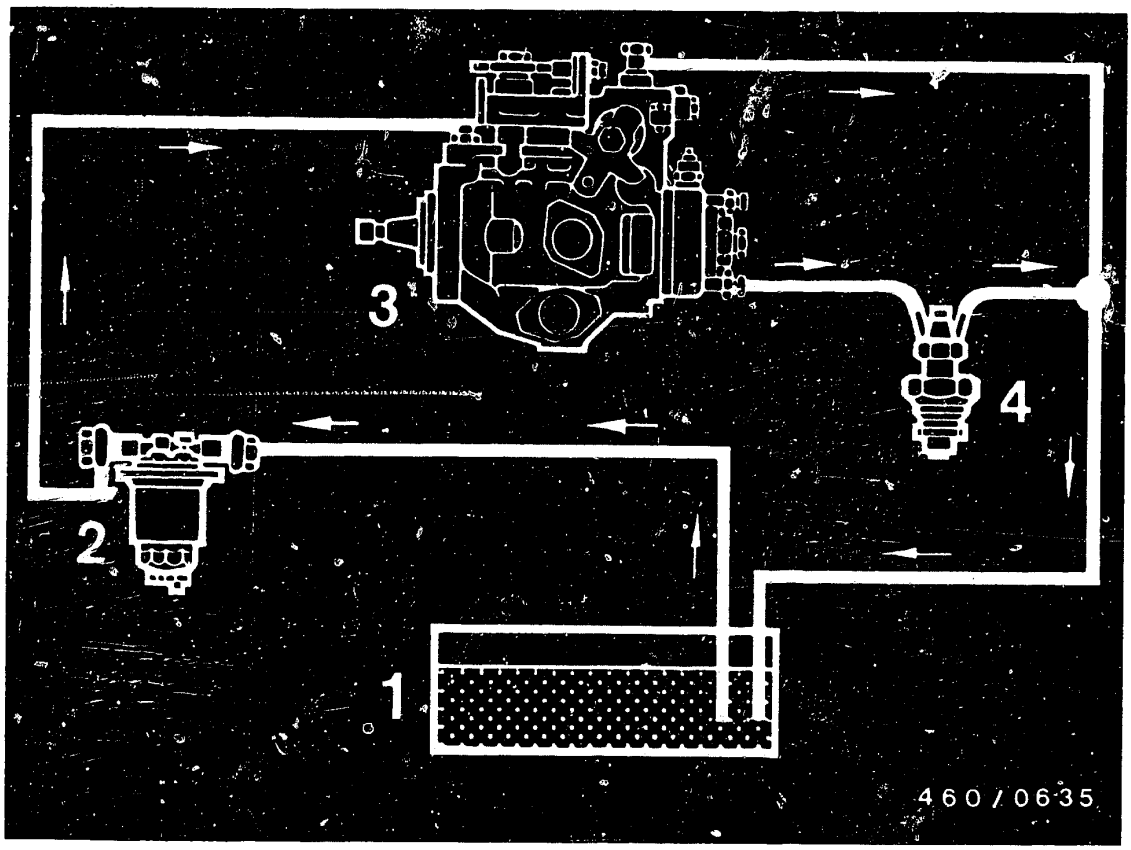
Operate the emergency stop lever on the injection pump (picture).



11.3 Solenoid-operated valve test

Remove fuel-injection tubing.
Take out solenoid-operated valve.
Cleanliness is essential.
When removed, check operation of solenoid-operated valve.

Note:
When removed, the solenoid-operated valve must only be supplied with voltage for a short period of time since it is no longer being cooled by the fuel.
Check valve seat in hydraulic head (visual inspection).

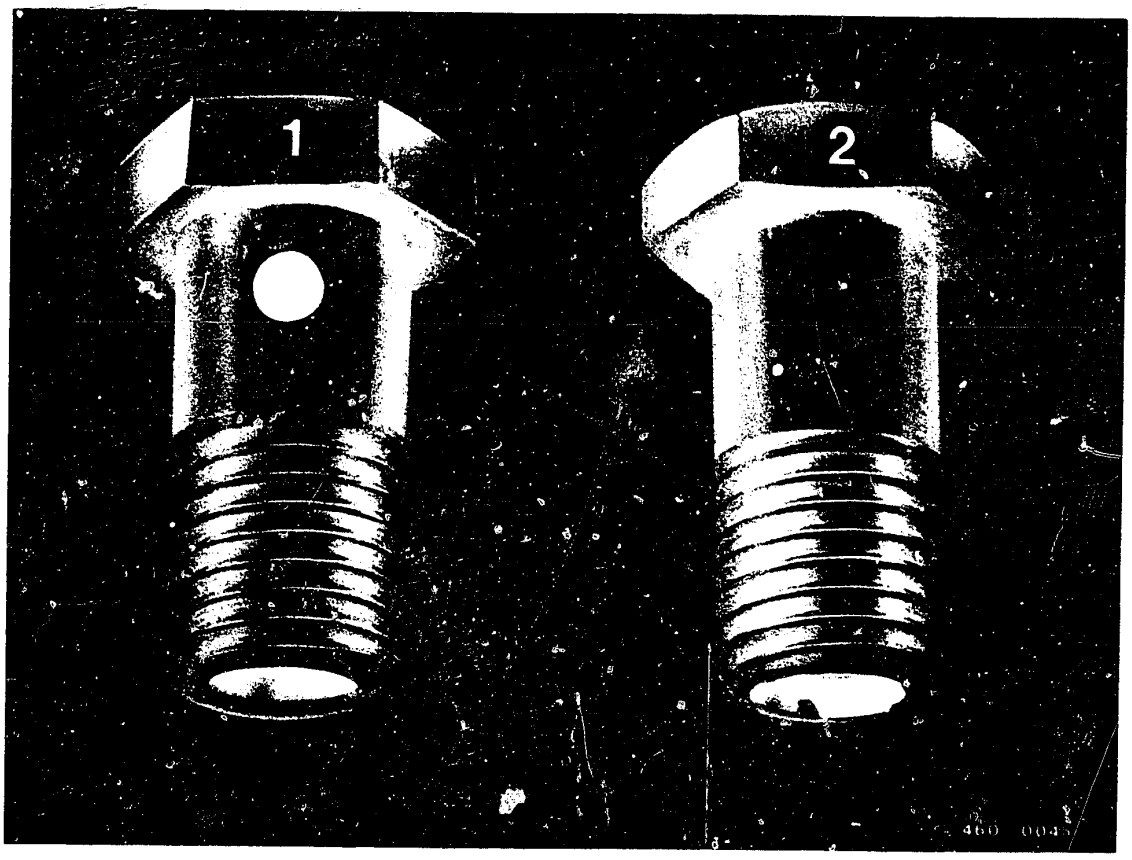


1 = Fuel tank
2 = Fuel filter
3 = Distributer-type injection pump
4 = Injection nozzles

12. Diagram of fuel lines

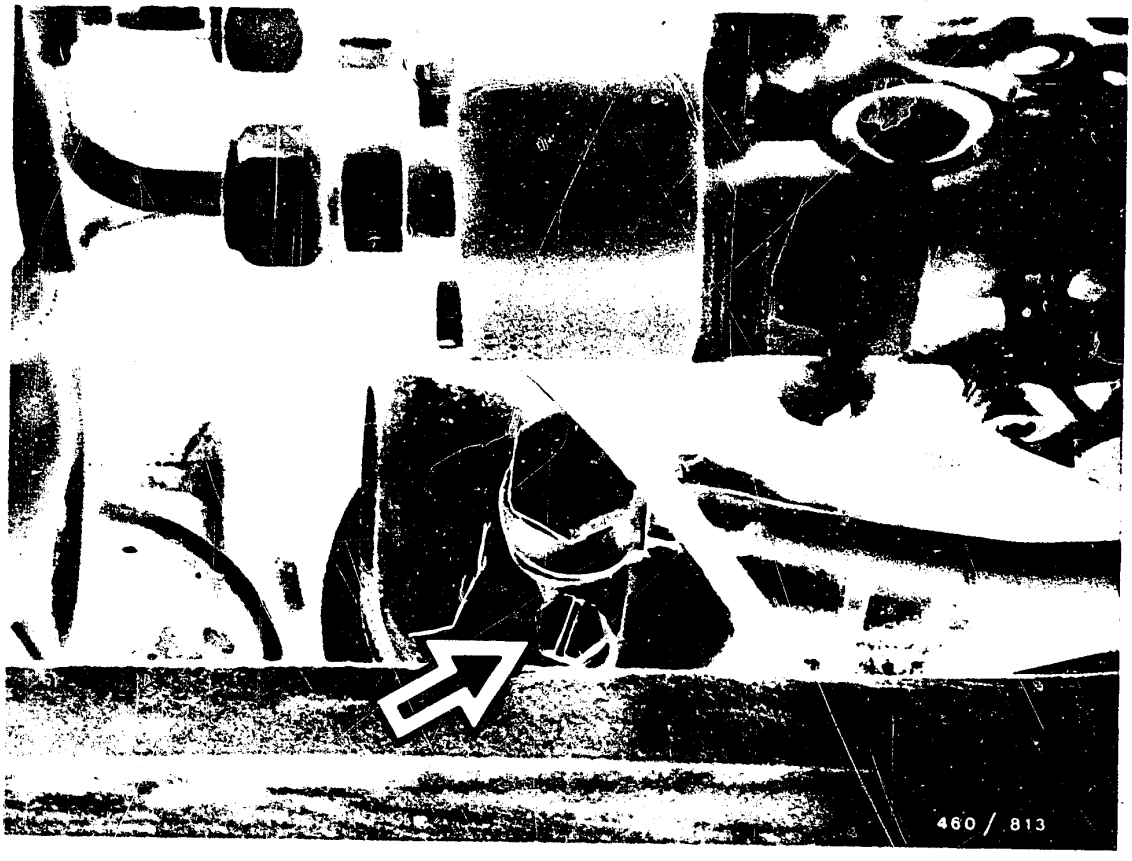
The fuel lines are connected in accordance with the above diagram.

The fuel flows in the direction of the arrows.



As regards the connections to the fuel-injection pump, ensure that the inlet-union screw for fuel inlet (1) and the throttle screw for fuel return (2) are not mixed up.

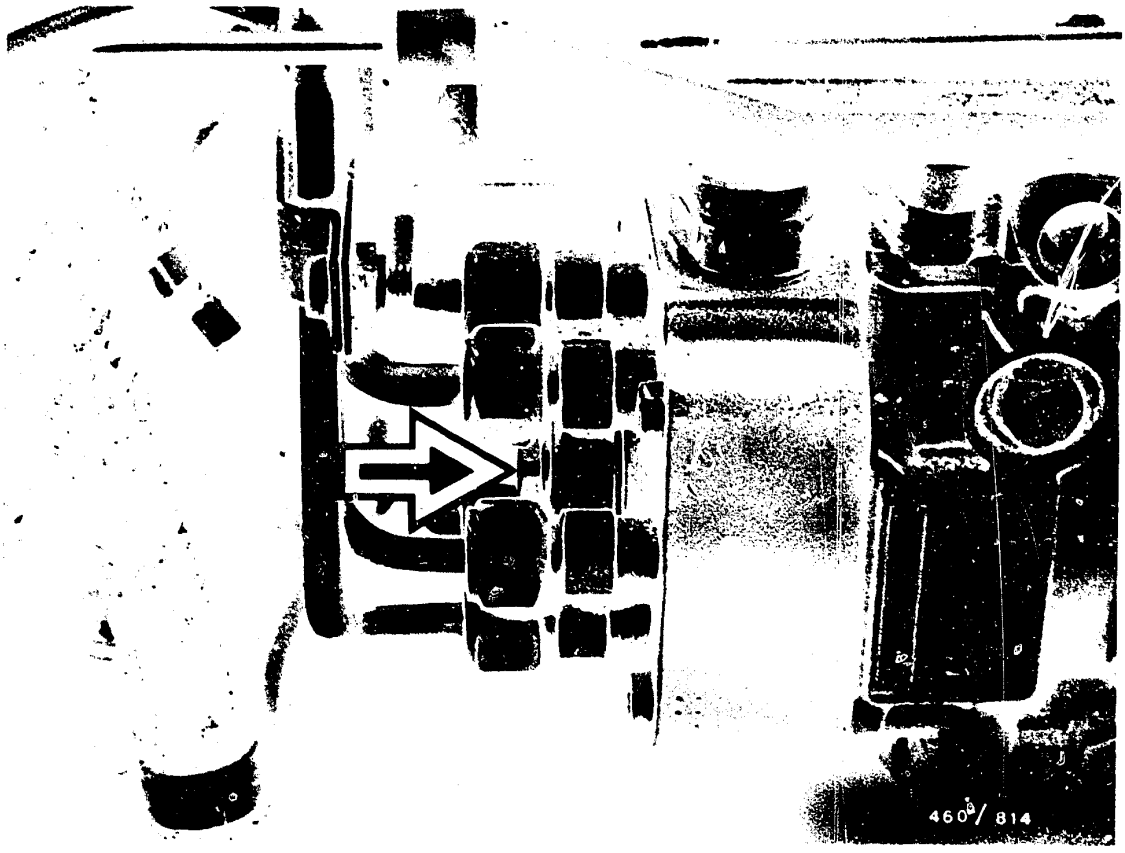
The throttle screw is located on the cover of the fuel-injection pump and the head of the screw is marked with the word "out".



13. Bleed fuel system

Fill the fuel filter and injection pump with diesel fuel.

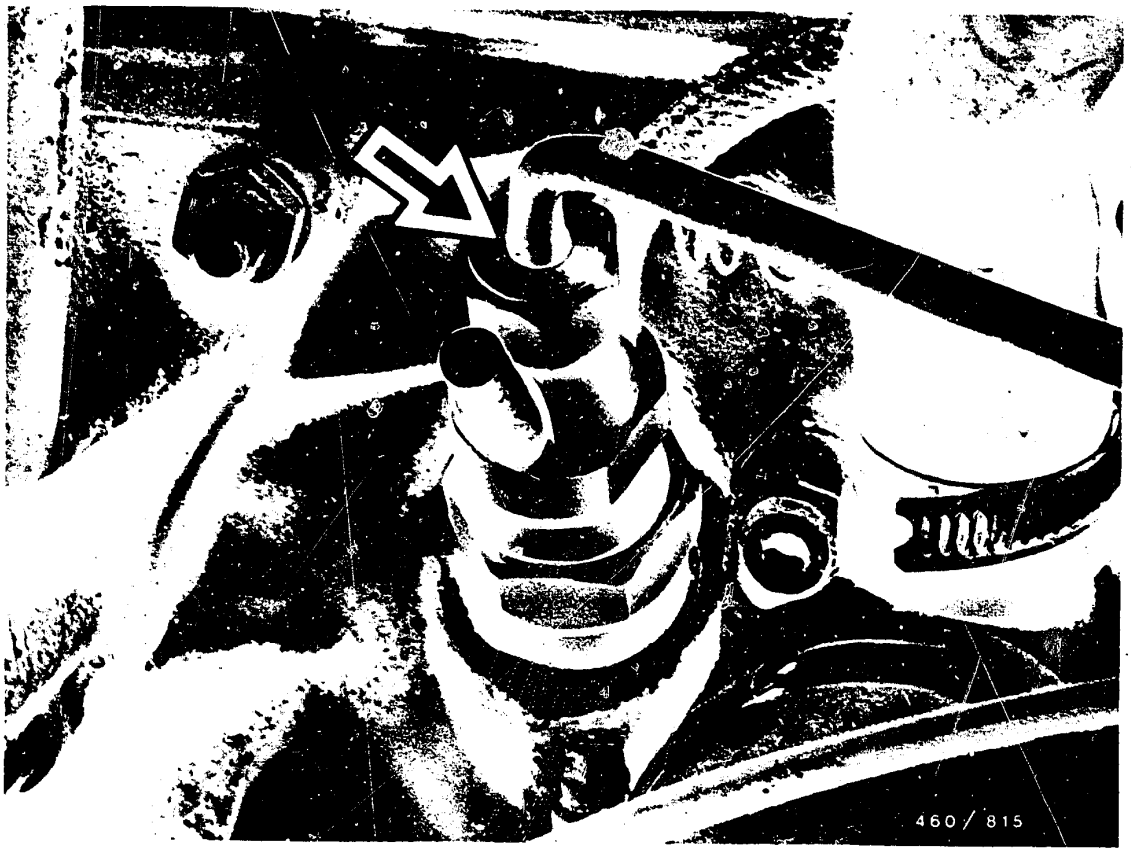
Tighten hose connections on filter cover.
If fitted, close bleeder screw on fuel filter (arrow).



Loosen bleeder screw on injection pump and screw out by a few turns (arrow).

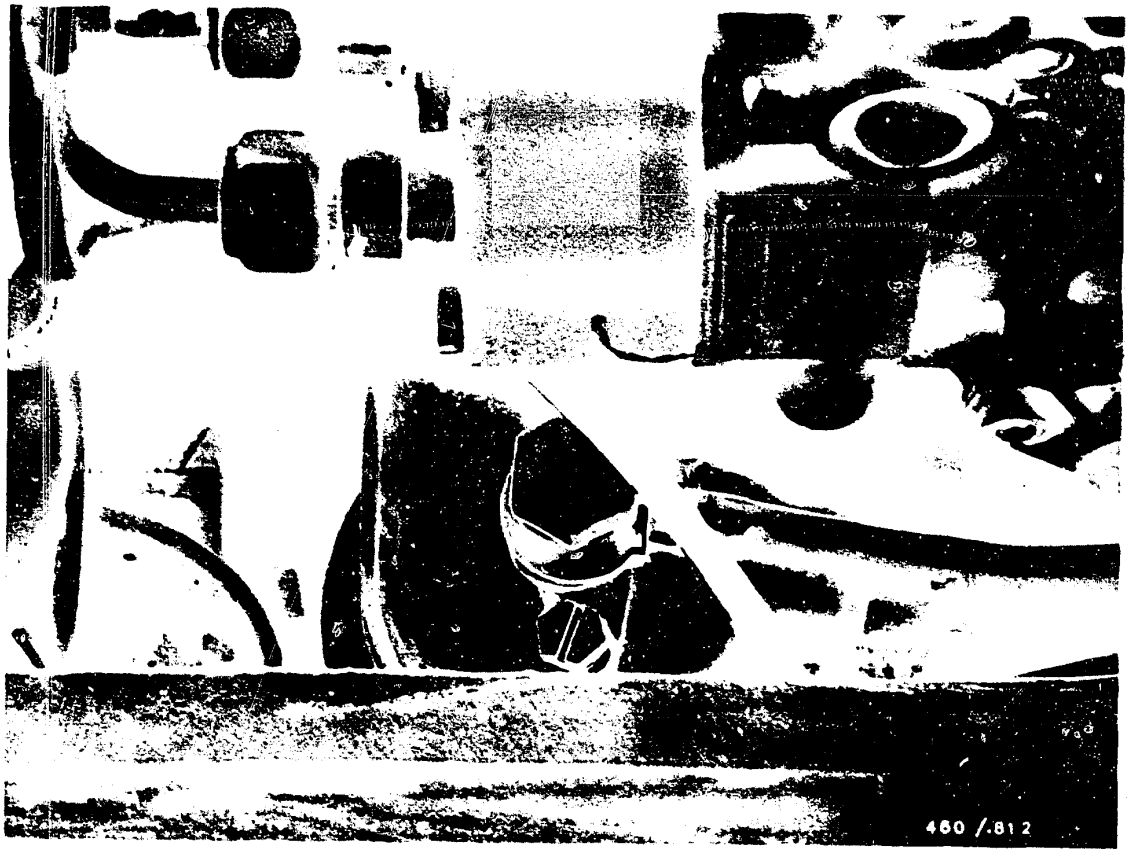
Loosen union nuts of fuel-injection tubing on nozzle holders.

Operate starting motor without preheating. When fuel escaping from bleeder hole of injection pump (arrow) is free of bubbles, tighten bleeder screw.



Continue to operate starting motor until fuel escapes from the union nuts of the nozzle holders (arrow).

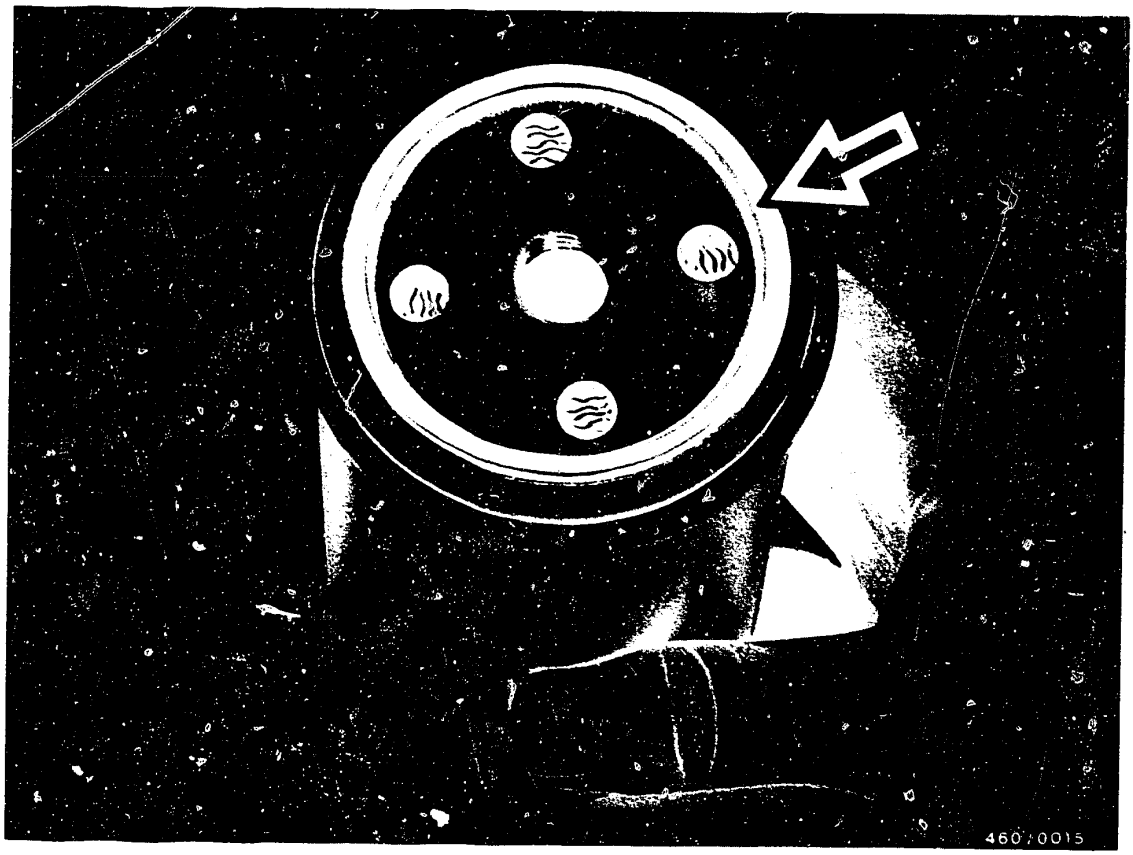
Tighten union nuts and operate starting motor until engine starts.



14. Replace and drain water from filter box

14.1 Replace filter box

Remove cover panel on underside of engine.
Unscrew filter box and drain.
Catch escaping fuel.



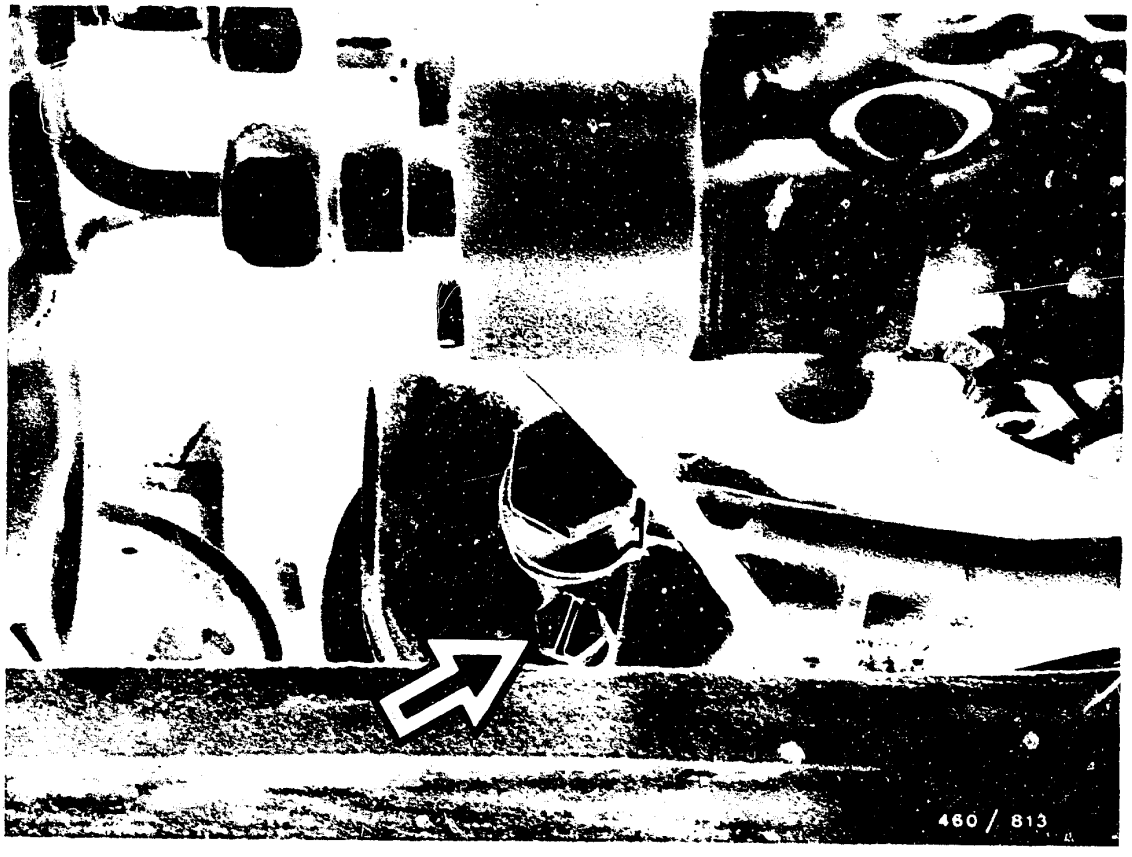
Rub diesel fuel into the rubber seal (arrow) of the new filter box.

Screw the filter box into the cover by hand and tighten.

Check the fuel filter for leaks.

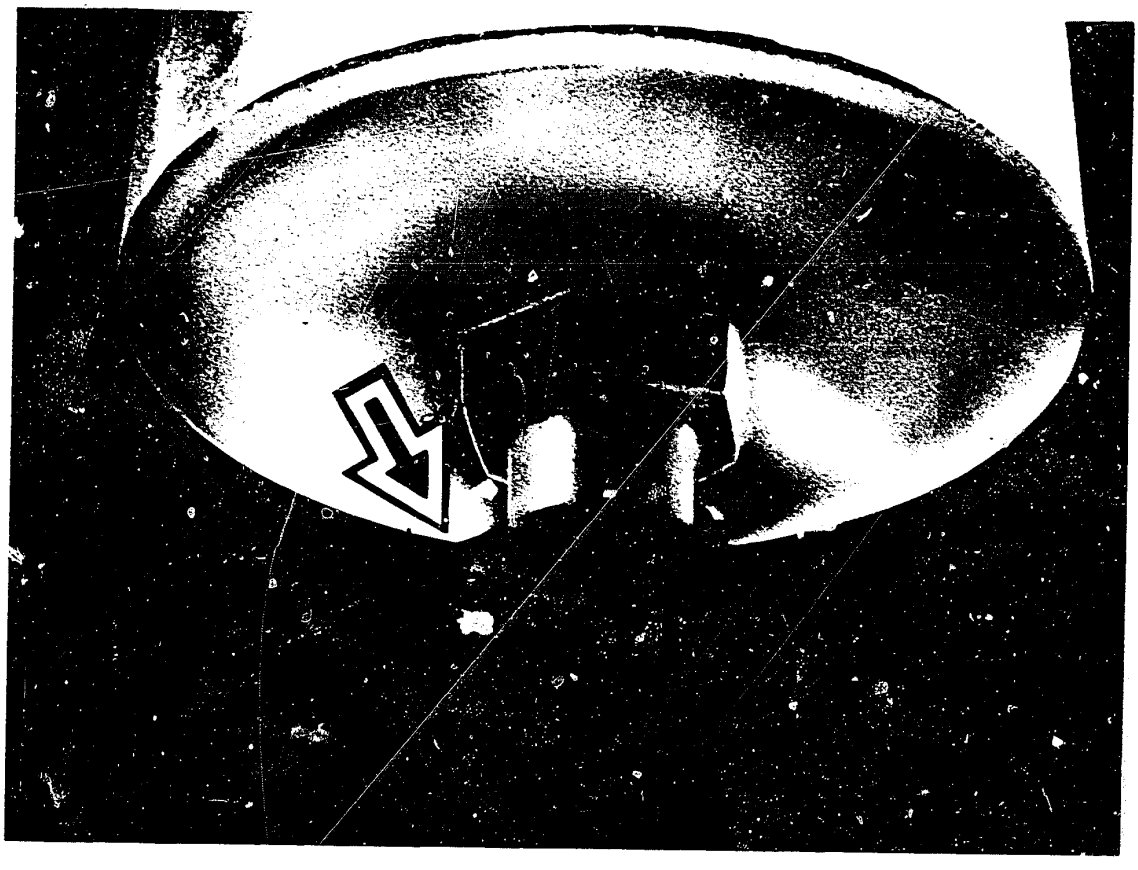
In the case of winter fuel it may be necessary to add petroleum as specified by the vehicle manufacturer.

Mount cover panel.



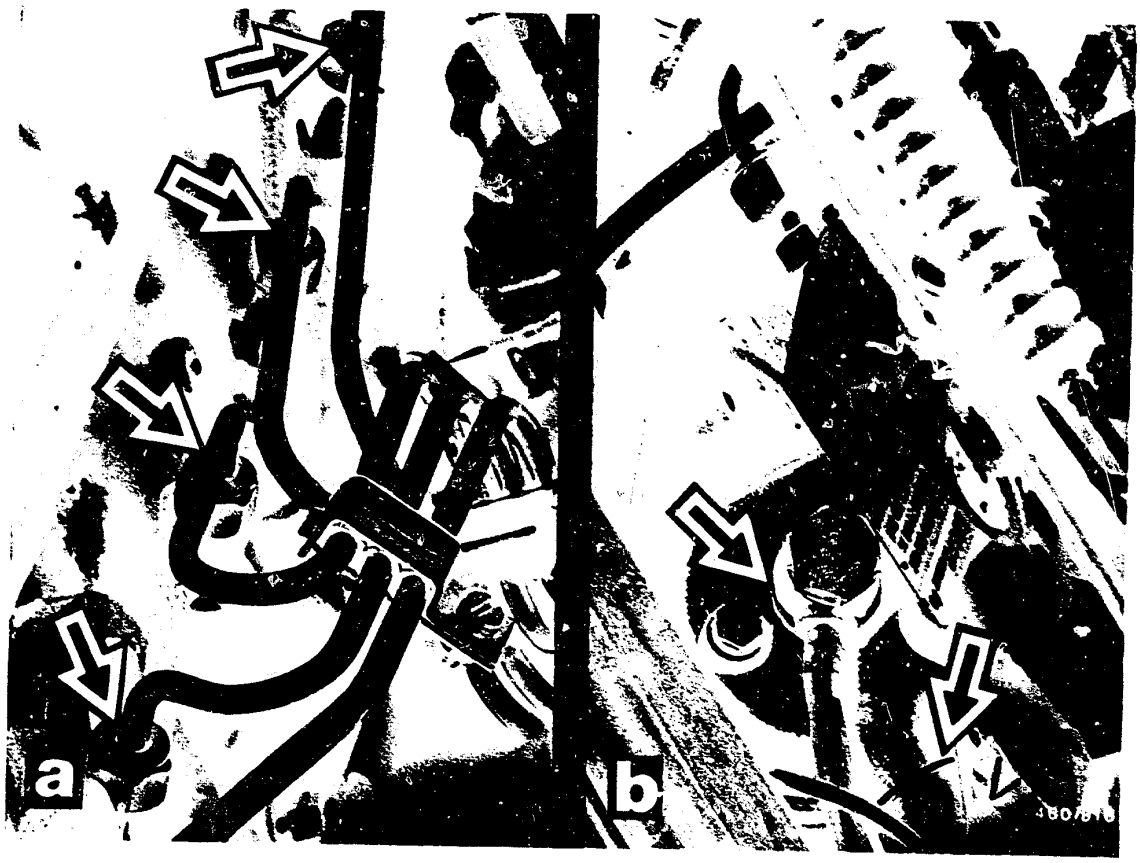
14.2 Drain water from fuel filter

Loosen bleeder screw (arrow) on filter cover by a few turns.
If there is no bleeder screw, remove leak-off hose from last nozzle holder (cylinder 6).



Loosen water-drain plug (arrow) on base of filter and drain approx. 100 cm^3 liquid into collector vessel.

Tighten water-drain plug and bleeder screw and check for leaks.
If necessary, reconnect leak-off hose to nozzle holder.



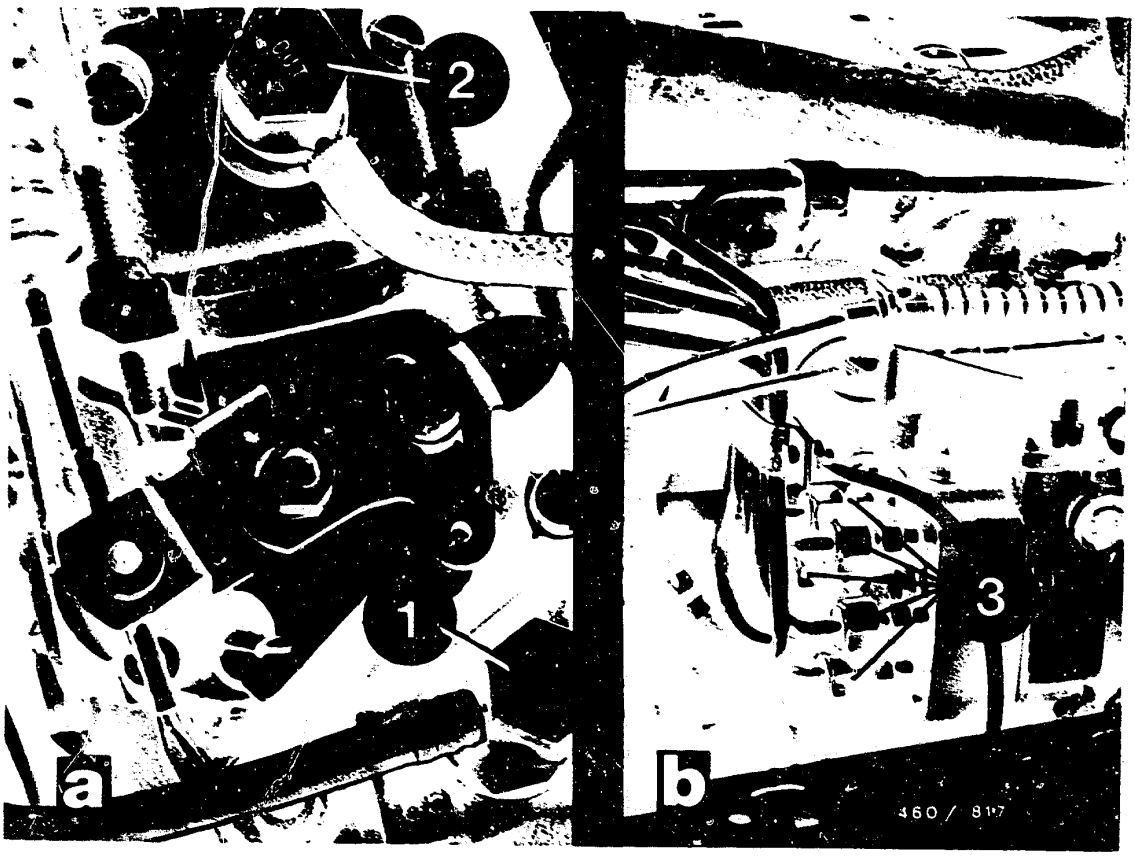
15. Test injection system for leaks

The leak test must be performed with the engine at normal operating temperature.

For the leak test, examine all connection points of the fuel lines.

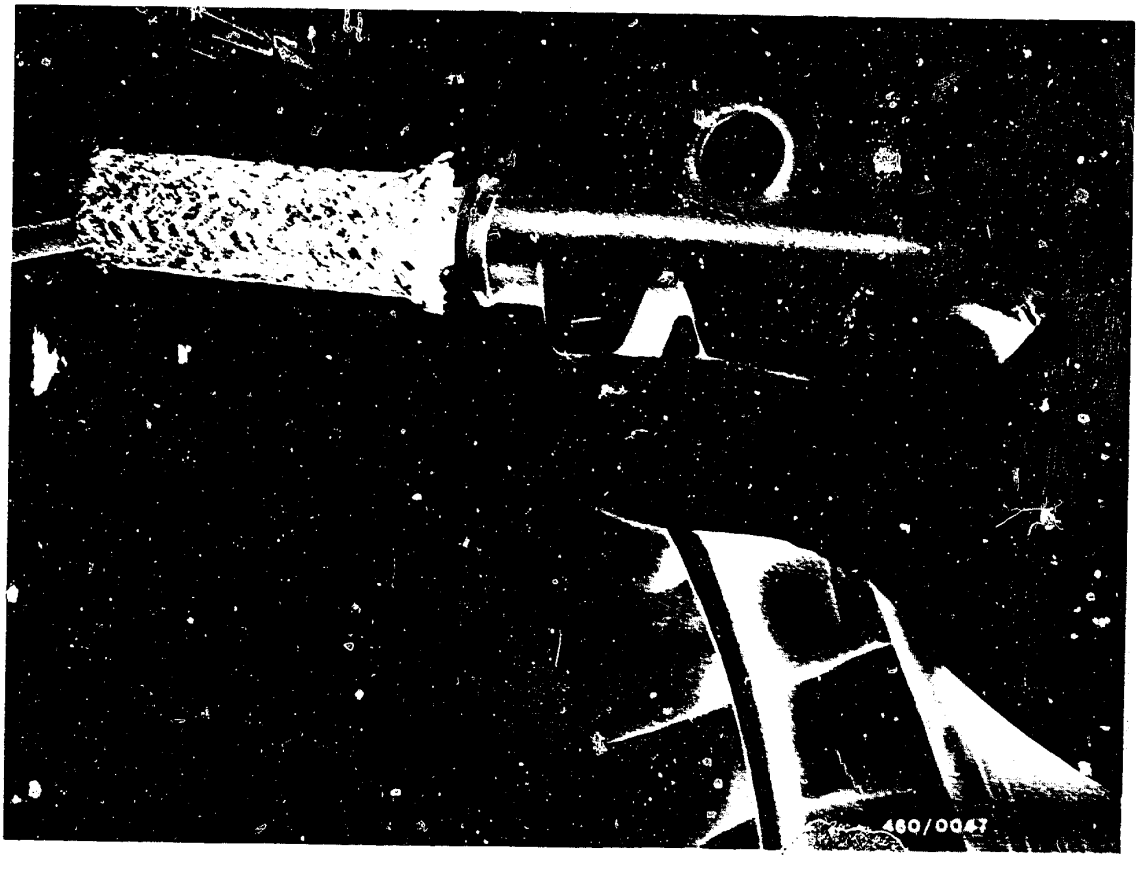
Pay particular attention to:

- Connections at nozzle-holder assemblies (arrows, Fig. a).
- Connections on fuel filter (arrows, Fig. b).



- Inlet line (1) and return line (2) on distributor-type injection pump.
- Delivery-valve holders on hydraulic head (3).

Examine fuel lines for hairline cracks.



16. Check fuel lines

Subject suspect fuel lines to a visual inspection.

If there is no detectable pinching or kinking, the fuel line in question must be removed.

Check fuel line for throughflow using compressed air and clean if necessary.

A suitable hose piece may be used as a side seal for blowing out the fuel lines.

17. Smoke test - check air filter

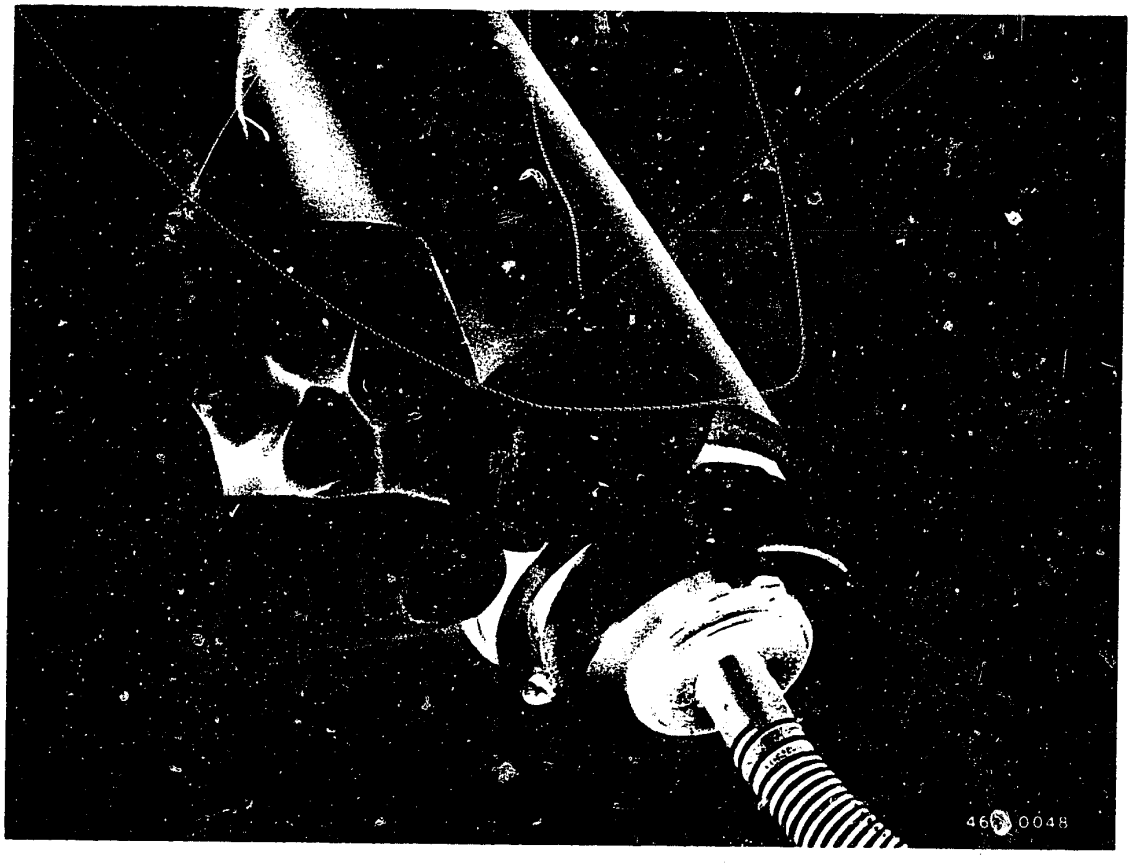
17.1 Smoke test

Summary of the contents of the legal regulations (as at April 1978). Applicable to Federal Republic of Germany.

This regulation applies only to the homologation of motor vehicles having at least 4 wheels with a maximum permissible speed of more than 25 km/h. A smoke emission test is not prescribed for official general inspections.

Parts which may have an influence on environmental pollution must be designed in such a way that the legal requirements are met during operation and despite vehicle vibration.

This applies in particular to cold-start devices and full-load stops. The Rheinland-Westfälische TOV (Technical Inspection Bureau of Rhineland-Westfalia) in Essen is the sole approval agency.

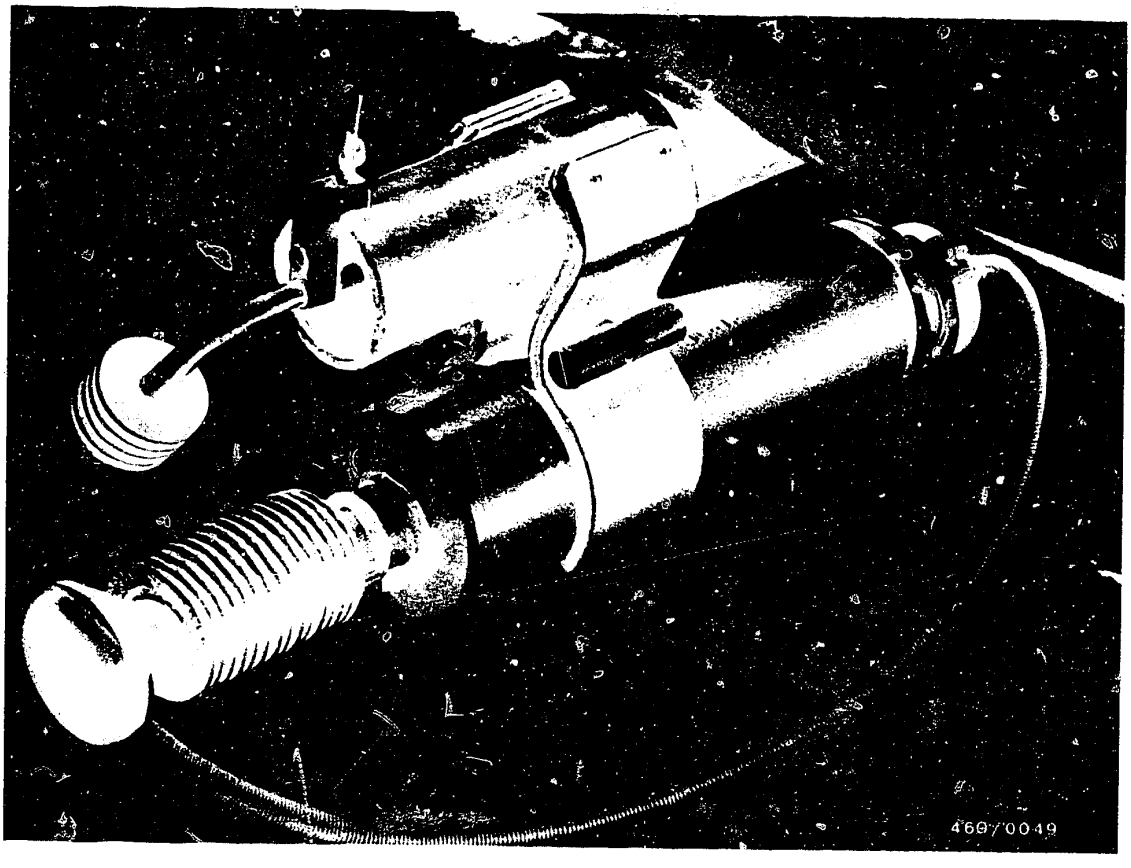


17.2 Test setup

The smoke test is conducted using the Bosch filter-type smokemeter.
The filter-type smokemeter consists of the following units:

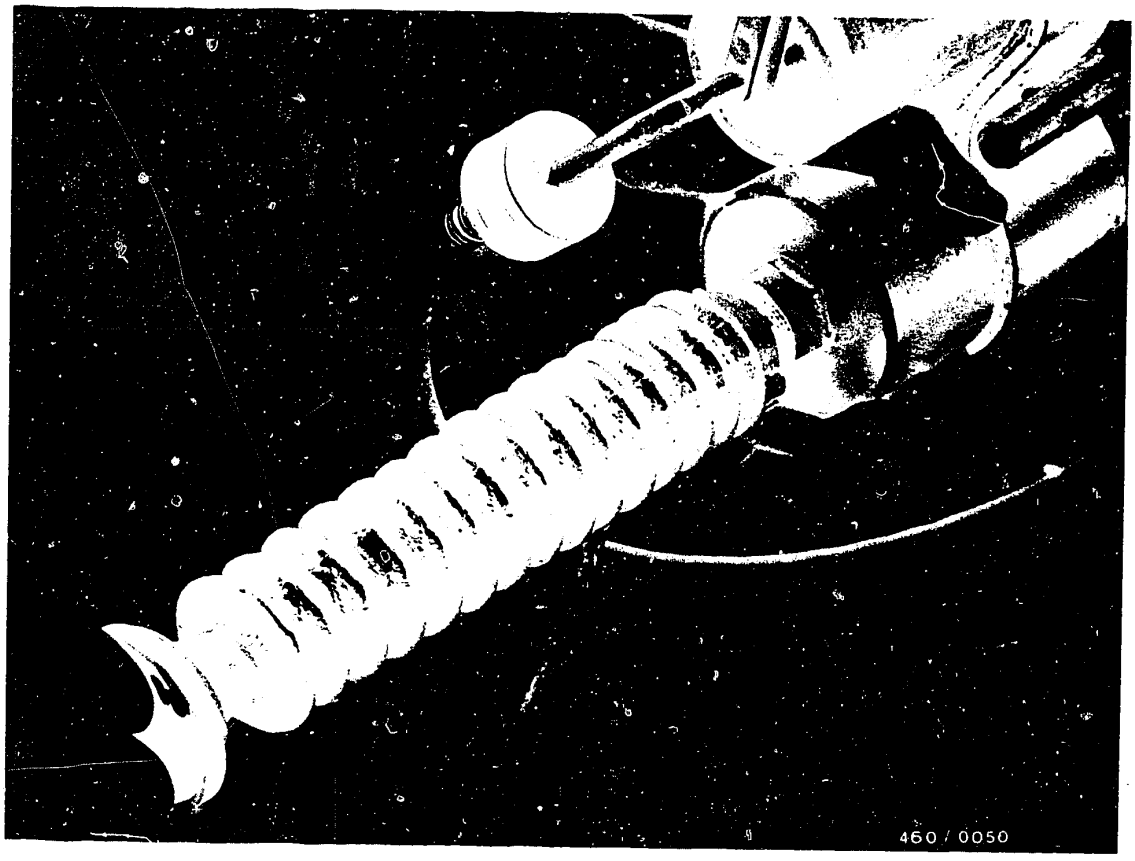
- Accessories box with proportioning pump — 0 681 169 038
- Evaluating unit — 0 684 102 050

Insert filter plate into proportioning pump.



Mount sampling pump on exhaust pipe using appropriate clamp.

Introduce exhaust-sample pickup as far as possible into exhaust pipe and clamp in position.

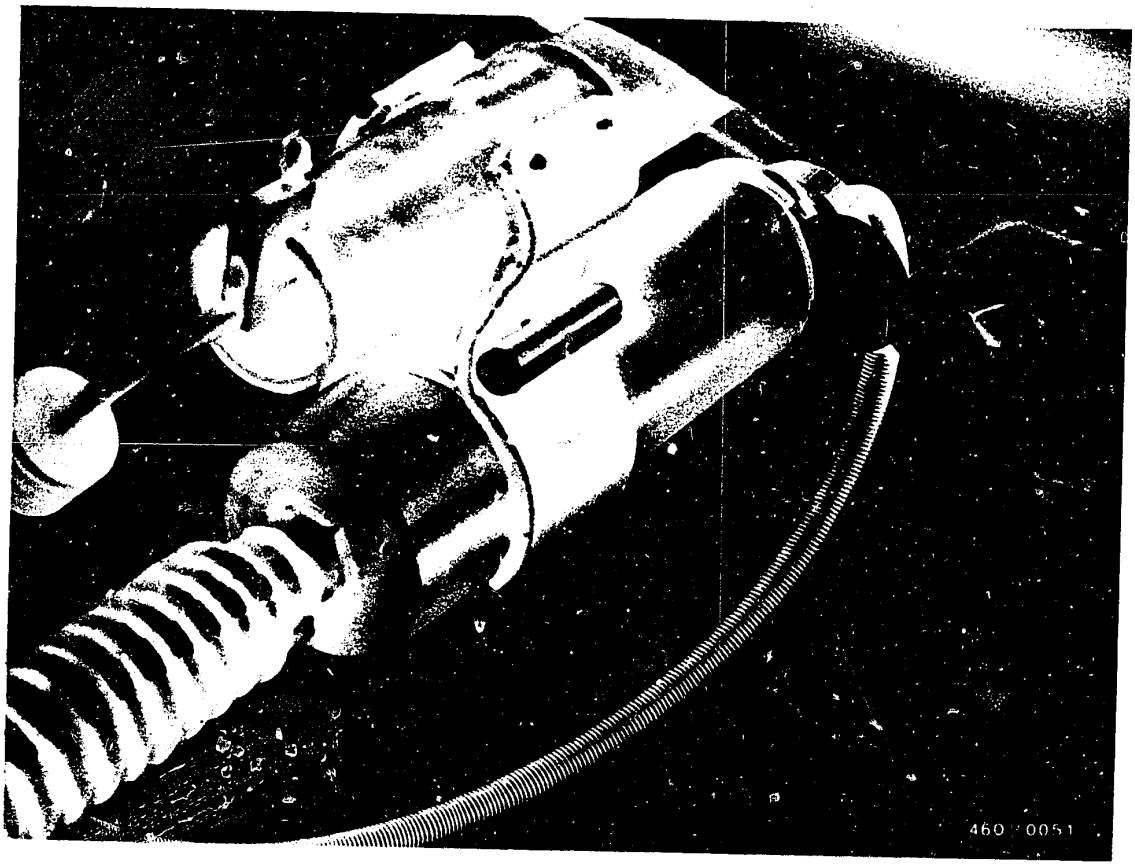


17.3 Test procedure

Set proportioning pump by pressing in the black push-button.
Take rubber ball on triggering hose and enter passenger compartment.

The test can be performed on the chassis dynamometer or on the road (gradient).

The chassis dynamometer is preferable in any case.
Find the gear in which, with the accelerator pedal in the full-load position, a speed of approx. 40 km/h is reached.



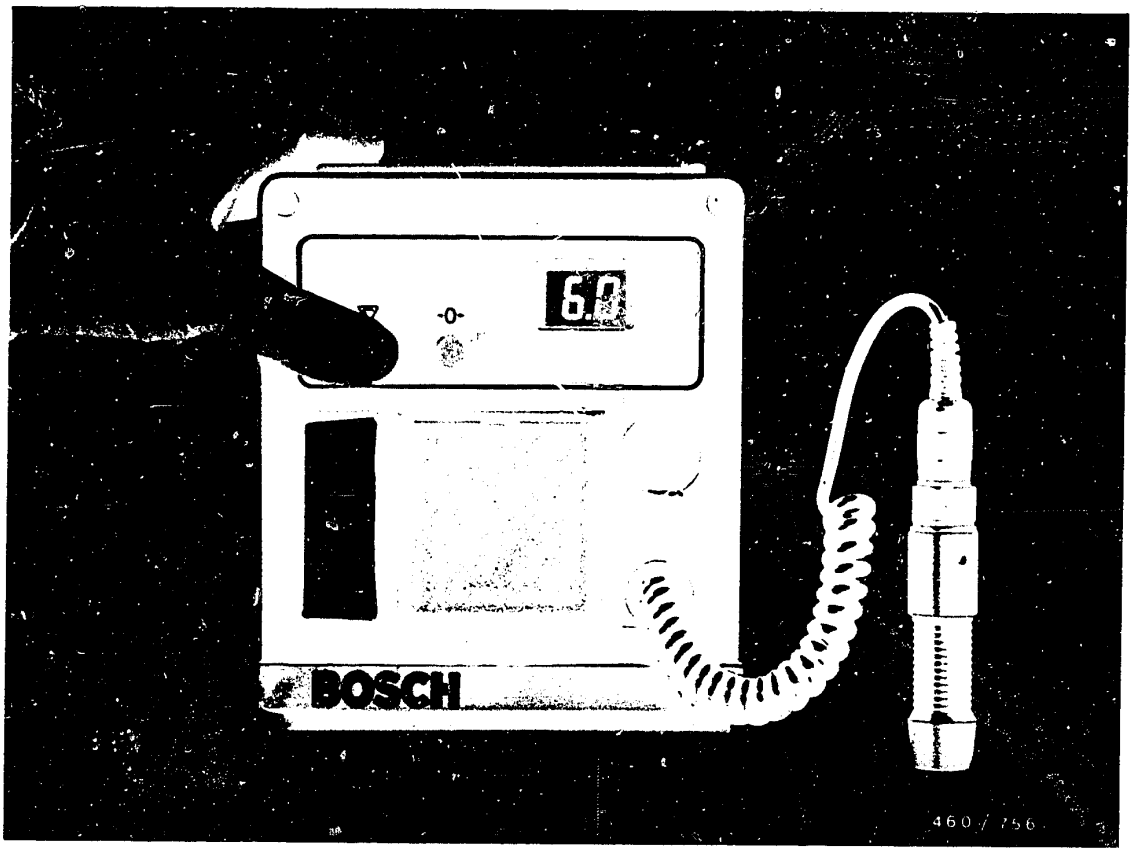
Load the engine so that, with the accelerator in the same position, a speed of approx. 25 km/h is reached.

Maintain this load condition for 5 seconds and then trigger the sampling pump by pressing the rubber ball.

Switch off engine.

Caution!
During the following operation, pay attention to the fact that the exhaust pipe has been heated due to the running of the engine.

Remove filter plate from sampling pump.



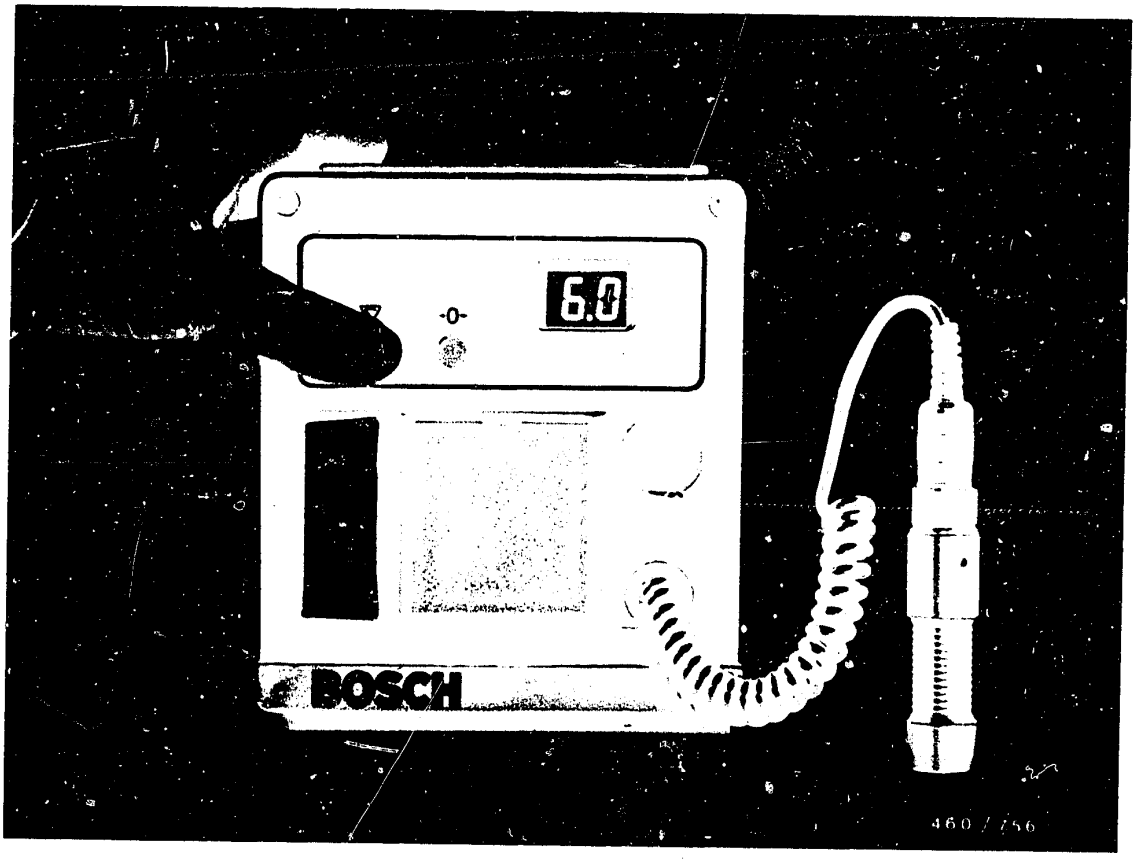
Setting the zero point

The zero point adjustment must be performed

- before each series of measurements
- in case of changes in ambient conditions
- each time the lens of the photoelement adapter has been cleaned.

Firmly press measuring head of photoelement adapter onto 5 clean, white filter plates placed one on top of the other.

Press button "0" until reading 0.0 appears. Release button "0".



Measuring

Place filter plate from metering unit, with sooted side up, on 3 new filter plates placed one on top of the other.

Press measuring head vertically onto black surface of filter plate.

At the same time press button"C" until measured smoke number appears in the display.

Note:
Measuring head must be firmly mounted both for the zero point adjustment and for measuring (even slight tilting may lead to incorrect measurements).

Compare established smoke number with evaluation sheet.
Note kW (HP) information of vehicle manufacturer.

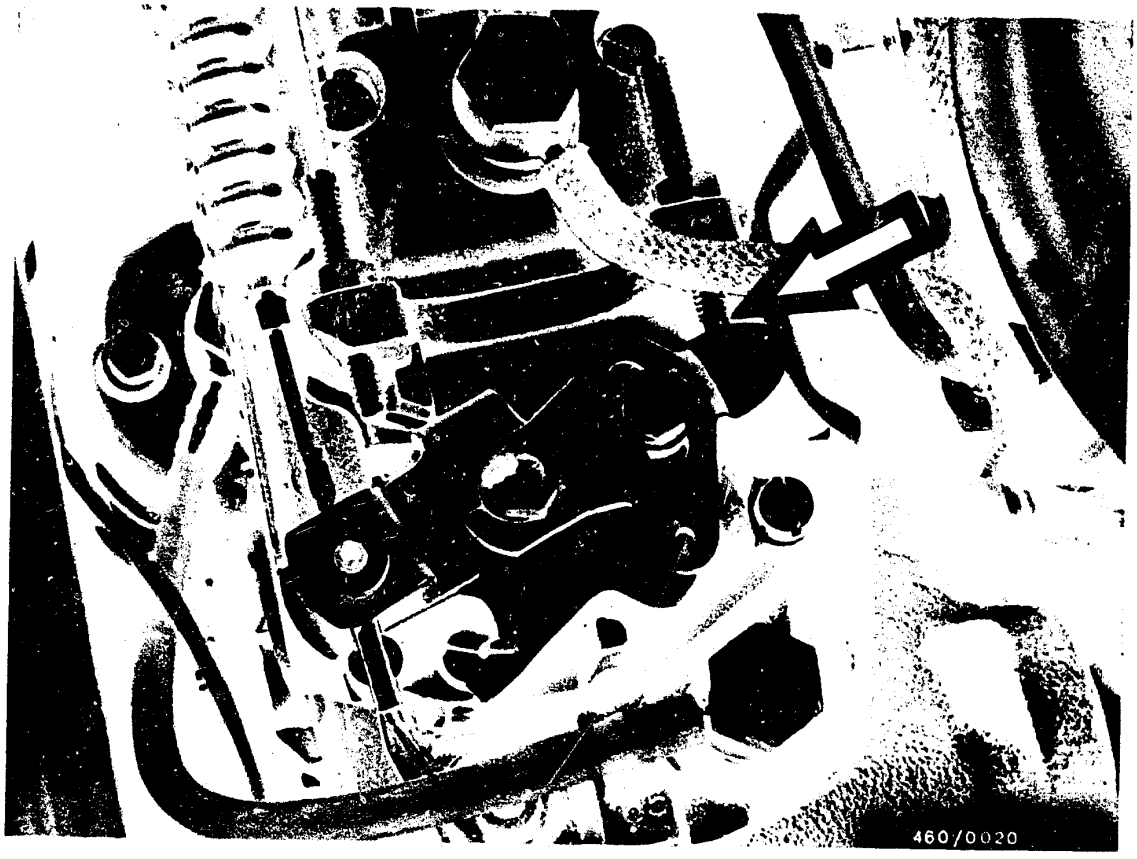
17.4 Check air filter

Remove air filter and subject to a visual inspection.

Test criteria for air filter:

- Dusty air filter (test by knocking out air filter)
- Oiled-up air filter
- Solid matter in air filter, e.g. leaves

If in doubt, use new filter element.



18. Idle speed

Connect tachometer (e.g. photoelectric) to engine.

Caution!

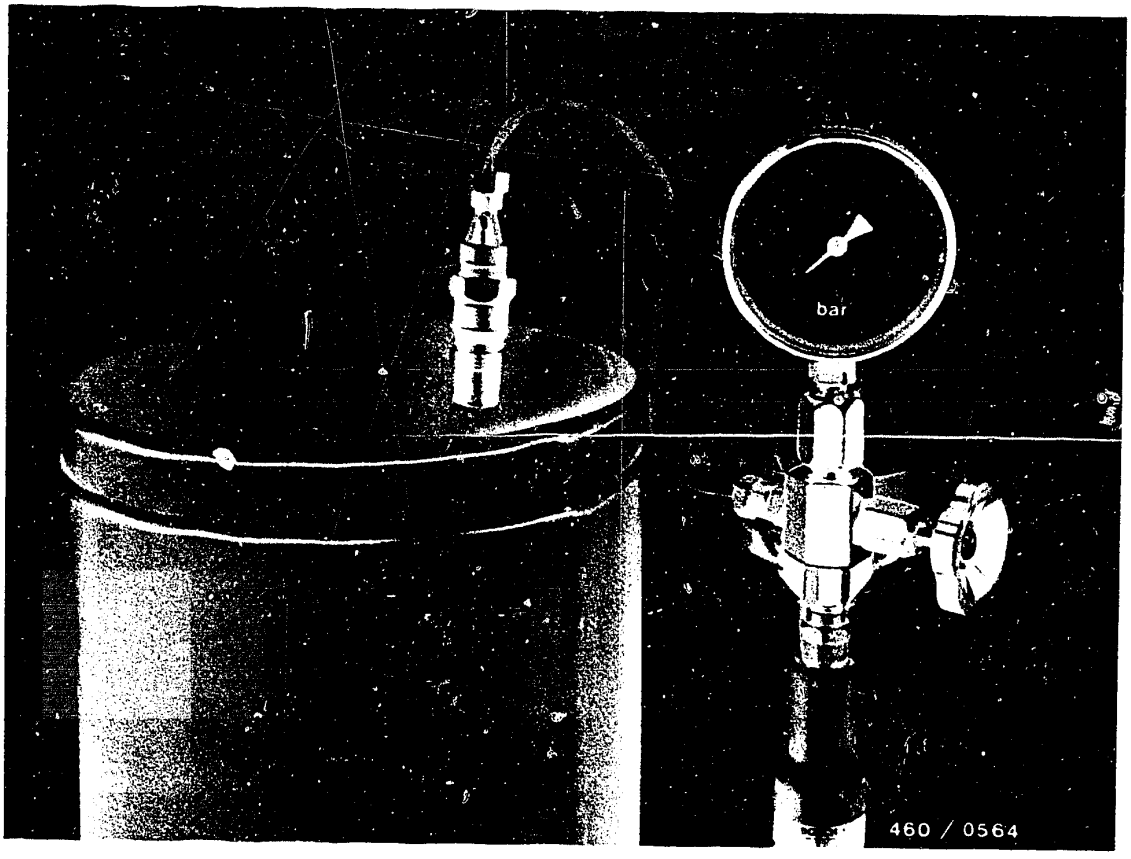
To set the idle speed, the engine must be at normal operating temperature.

Coolant temperature + 80°C.

Set engine speed to 750 ± 50 min^{-1} at the idle-speed adjusting screw (arrow).

Note that the engine camshaft and injection pump are driven at half the engine speed.

After setting, lock and seal adjusting screw.



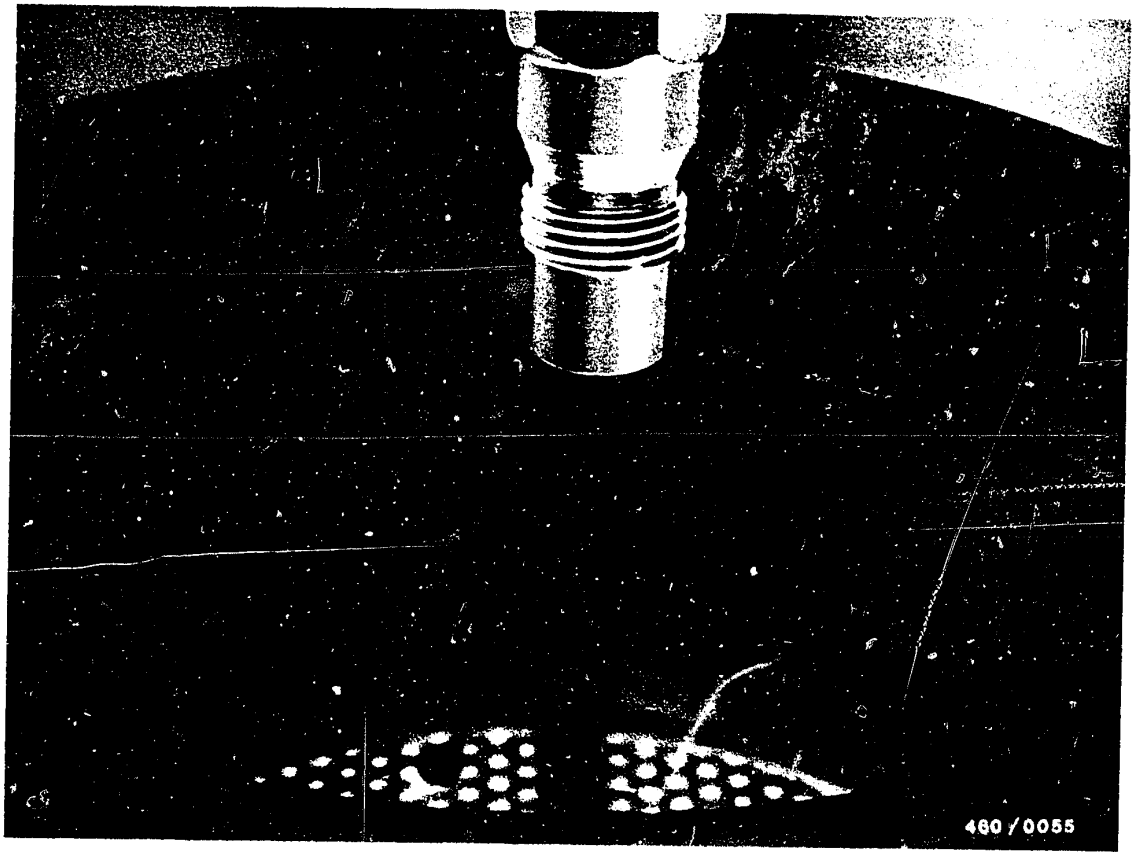
19. Test injection nozzles

Remove injection nozzles.

The test is performed using the nozzle tester EFEP 60 H/ 0 681 200 502.

Mount injection nozzle with nozzle-holder assembly on nozzle tester.

Caution:
When testing injection nozzles, make sure that the fuel spray does not strike your hands since, due to the high pressure, the fuel will penetrate into the skin and may cause blood poisoning.



19.1 Spray test

Switch off pressure gauge.

The spray pattern cannot be assessed until when the lever is being operated quickly (approx. 4-6 strokes per second). The spray must be quite concentrated and break off cleanly.

19.2 Chatter test

The pressure gauge is switched off.
Fully depress the lever of the tester slowly (1-2 strokes per second).
Nozzles in good working order must chatter when fuel escapes.

19.3 Check injection pressure

Switch on pressure gauge.
Slowly force lever downwards. When nozzle begins to squirt, read off injection pressure.
In the case of deviations from the nominal value, the nozzle-opening pressure must be adjusted by shims behind the pressure spring in the nozzle-holder assembly.

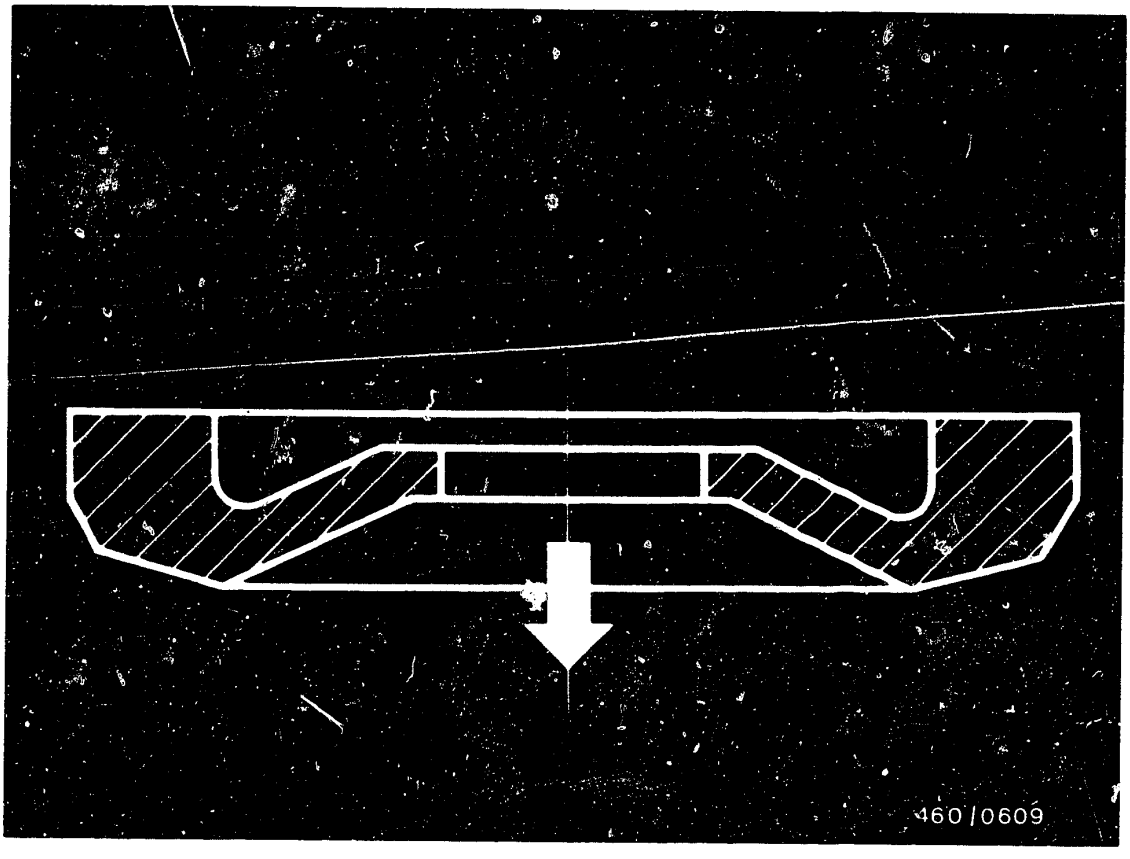
Nominal value: 130+8 bar

Thicker shims = higher nozzle-opening pressure
Thinner shims = lower nozzle-opening pressure

Shortening the spring travel by 0.05 mm causes an increase in the nozzle-opening pressure of 5.0 bar.

19.4 Leak test

Pressure gauge on.
Slowly press lever downward and maintain pressure approx. 20 bar below the opening pressure for 10 seconds. No drop may fall from the nozzle.

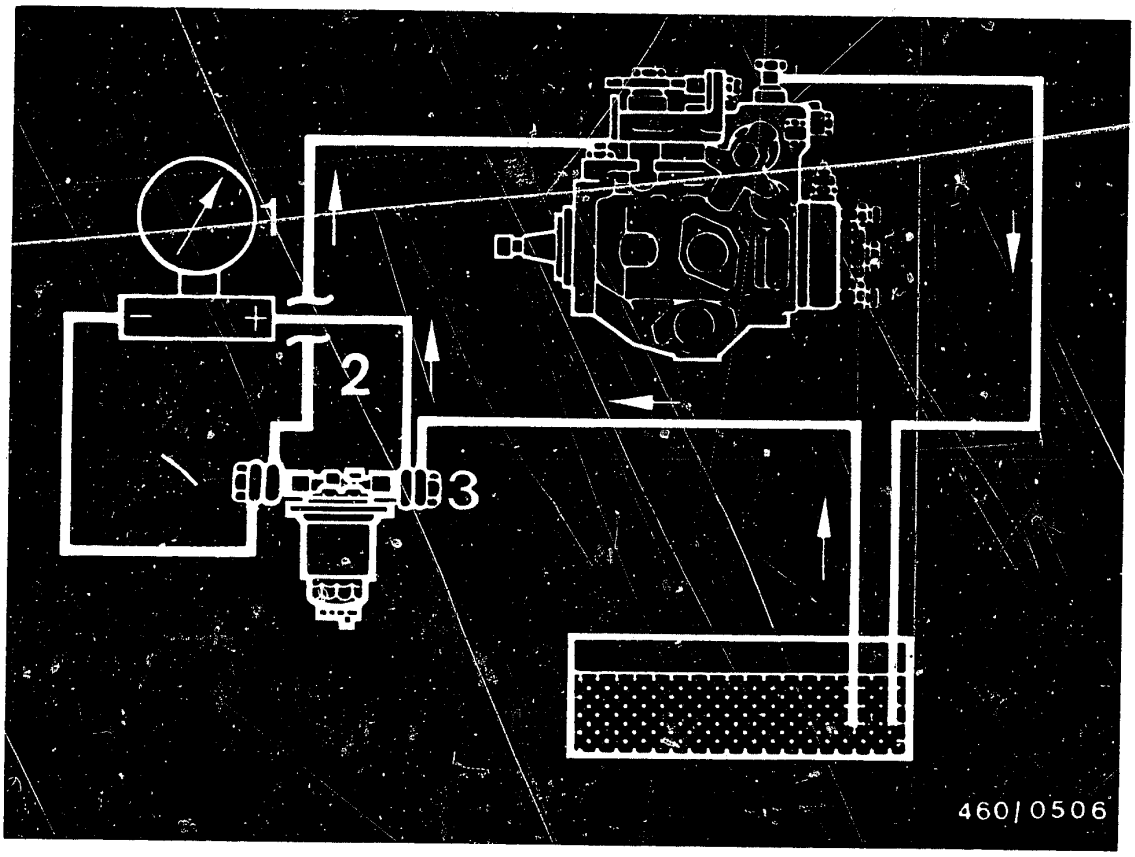


19.5 Install injection nozzles

Before installing the injection nozzles, fit a new heat seal in the direction of the arrow with respect to the cylinder head (Picture).

Tighten the fastening screws of the nozzle-holder assembly to 70 Nm (7.0 kgfm).

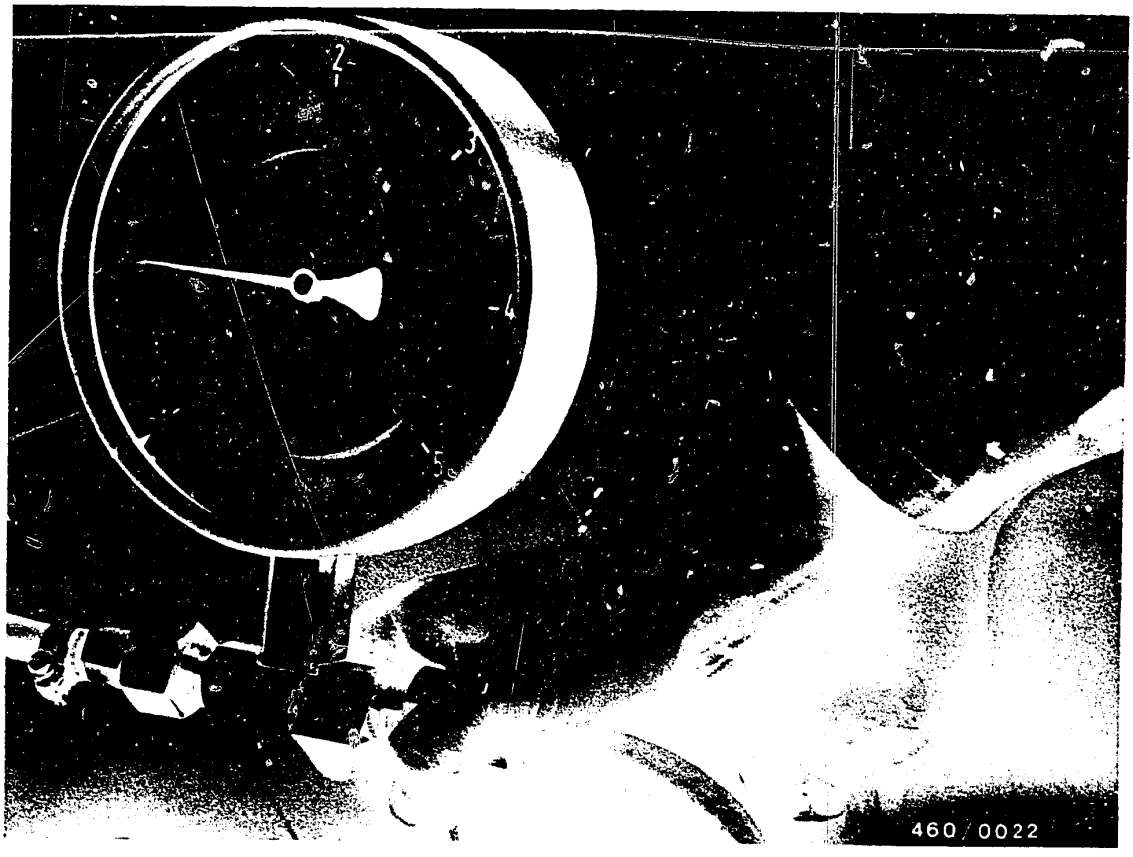
Tighten the union nuts of the fuel-injection tubing to 25 Nm (2.5 kgfm).



1 = Differential-pressure gauge
2 = Filter outlet (use inlet union and extra-long inlet-union screw 2 443 456 020)
3 = Filter inlet (use inlet union and extra-long inlet-union screw 2 443 456 020)

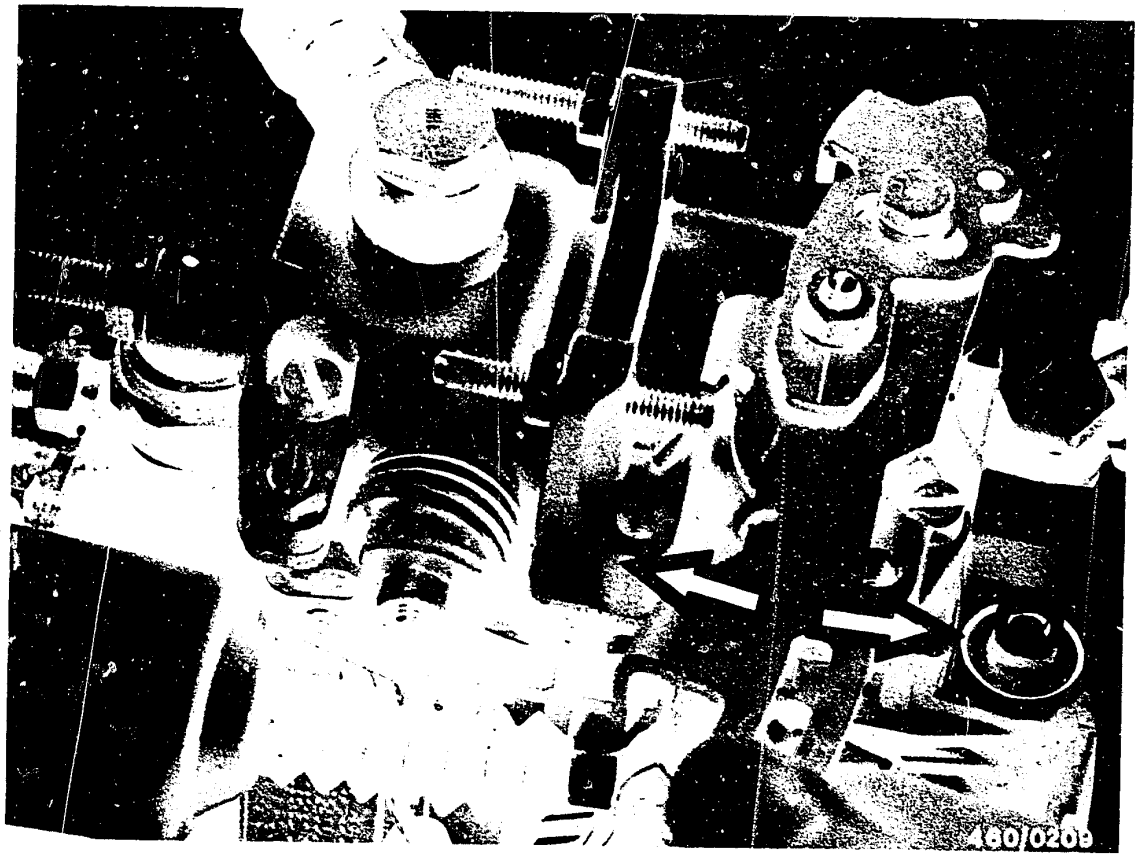
20. Connection diagram for filter test

Connect differential-pressure gauge to fuel filter using appropriate connecting pieces.



Connect the (+) side of the differential-pressure gauge to the fuel filter inlet. Fit the (-) connection of the pressure gauge to the filter outlet. See connection diagram.

Run engine until you are sure that there is no air in the fuel system.



Move injection-pump control lever briskly (approx. 1 sec) from the idle stop to the maximum speed stop.

Release control lever and read off differential pressure on pressure gauge.

The differential pressure may be max. 0.3 bar. If this value is exceeded, replace filter. Remove test connections.

If necessary, bleed fuel system.

21. Test preheating system

21.1 Necessary test equipment

Voltmeter/ammeter e.g. ETT 011.00 part no 0 684 101 100

21.1 Workshop information

We recommend that the R-type sheathed-element glow plugs be replaced every 45 000 km.

Note:

Incorrect setting of the start of delivery may considerably reduce the life of the sheathed-element glow plugs.

- Preheating times

  The on-time of the preheating system is dependent on the ambient temperature.

- Conditions for testing

  Battery fully charged.
  Compression O.K., if necessary test compression loss.

  Fuel supply/injection system O.K.

Check pre-heating system

Note:

All engines are equipped with a rapid preheating system.

Test power supply

- Connect test lamp between power supply to cylinders 1 - 3/ 4 - 6 and ground.
- Disconnect lead from engine-temperature sensor.
- Turn ignition key to pre-heating for max. 15 seconds; test lamp must light up.
- Reconnect lead to engine-temperature sensor.

Test lamp lit?

Yes →

No ↓

Continued on C21/C22

The glow plugs can be tested either with a test lamp or with the voltmeter/ammeter ETT 011.00.

1. Testing the voltage of the glow plugs with test lamp:

- Remove lead and bus bar for glow plugs.
- Connect test lamp to battery + and contact against each glow plug one after the other.
- Lamp lit = Glow plug O.K.?
- Lamp not lit, glow plug defective, replace (tightening torque 40 Nm).
  See note in case of burned elements.

2. Testing the power supply to the glow plugs with voltmeter/ammeter ETT 011.00:

- Connect ammeter (e.g. ETT 011.00) into lead for glow plugs.
- Remove lead from engine-temperature sensor.
- Turn ignition key to "pre-heating" for max. 15 seconds.
- Read off current consumption.

  Set value: 72 A

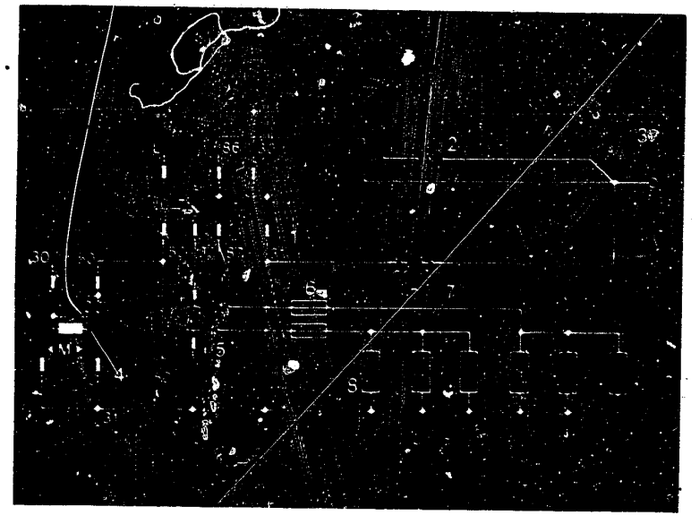
Set value reached?

No →

Note:
Current consumption after stabilization approx. 12 A per glow plug. If there is a current consumption of the glow plug of approx.
60 A = One glow plug defective
48 A = Two glow plugs defective
36 A = Three glow plugs defective
These current readings are obtained only with a battery voltage above 11.5 V.

Yes ↓

Glow plugs O.K.
(Fault is in the fuel supply).



1 = Glow-duration unit
2 = Glow-plug indicator lamp
3 = Battery
4 = Starting motor
5 = Temperature sensor
6 = Fuses 80 A
7 = Solenoid-operated valve
8 = Glow plugs

Check pre-heating system (continued)

Fuse for glow plugs defective

- Check fuse for glow plugs.

Test lamp lit?

No → Replace defective fuse.

Yes ↓

Terminal 30 on relay for glow plugs not receiving any voltage

- Connect test lamp to terminal 30 of relay.

Test lamp lit?

No → Open circuit between terminal 30 of relay board and terminal 30 of relay.

Relay board defective, replace.

Yes ↓

Relay for glow plugs not triping

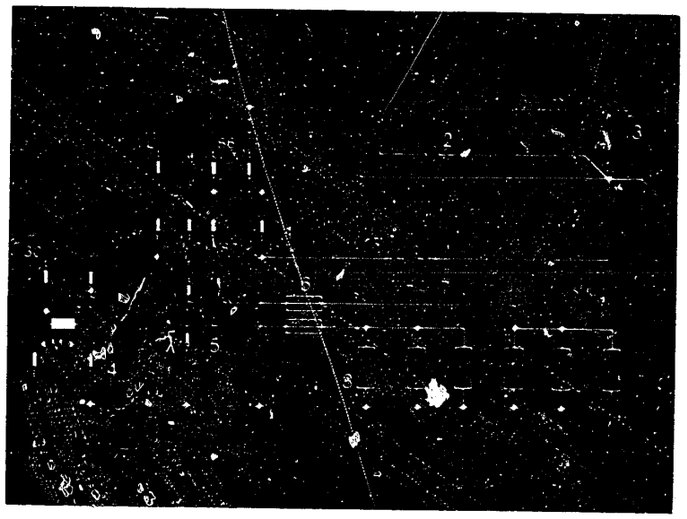
- Connect test lamp to relay terminal 86.
- Turn ignition key to pre-heating.

Test lamp lit?

No → Repair connection between relay board and terminal 86 of relay, or replace relay board.

Yes ↓

Repair connection from terminal 85 of relay to ground or replace relay.



1 = Glow-duration unit
2 = Glow-plug indicator lamp
3 = Battery
4 = Starting motor
5 = Temperature sensor
6 = Fuses 80 A
7 = Solenoid-operated valve
8 = Glow plugs

Note:
If engine starts poorly, also check the functions of the automatic afterheating and the heating during starting.

1. There must be voltage across the glow plugs for a further 6 to 7 seconds after the end of the temperature-dependent pre-heating time (repeater lamp goes out). Do not switch on starting motor for this test. If there is no voltage across the glow plugs, replace pre-heating control relay.
2. There must be voltage across the glow plugs while starting (starting motor switched on). If there is no voltage across the glow plugs, repair the lead from pre-heating control relay terminal 50 to starting motor, or replace pre-heating control relay.

Test pre-heating repeater lamp

Test light-emitting diode
- Remove pre-heating control relay.
- Connect terminal "L" in the relay base to ground using test lead.
- Switch on ignition.

Pre-heating repeater lamp lit?

No → Light-emitting diode defective - replace.
Test lead from relay terminal L to light-emitting diode for continuity.

Yes ↓

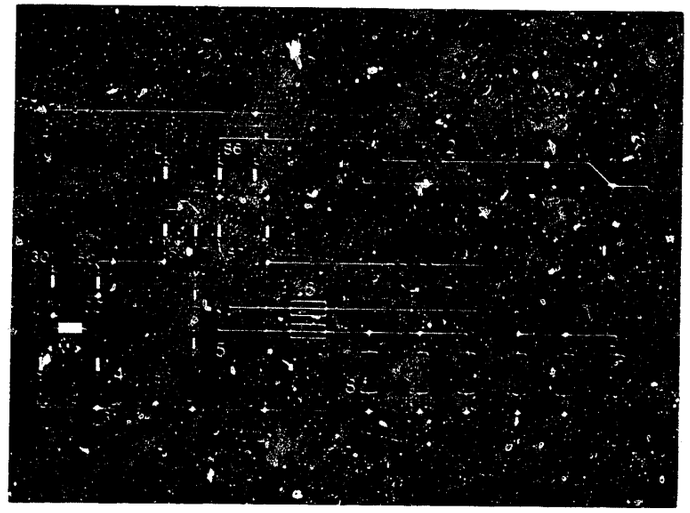
Pre-heating control relay and/or engine-temperature sensor defective.
Test operation of relay (see note above)
- Remove lead for glow plugs.
- Disconnect lead from engine-temperature sensor.
- Switch on ignition. Repeater lamp must light up for approx. 25 - 30 sec.
- Connect lead from engine-temperature sensor to ground: repeater lamp must go out.

Light-emitting diode lit?

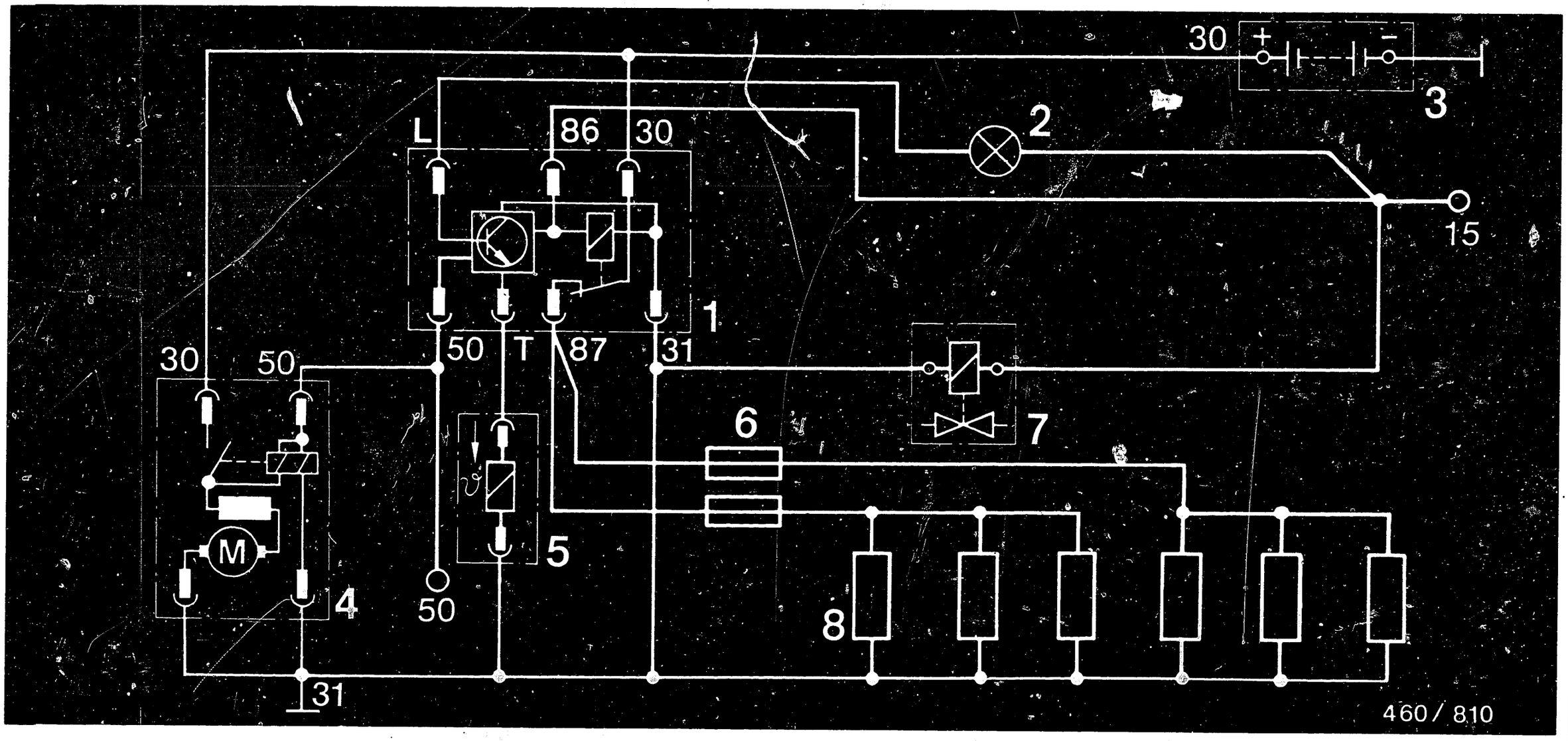
No → Replace pre-heating control relay.

Yes ↓

Replace engine-temperature sensor.

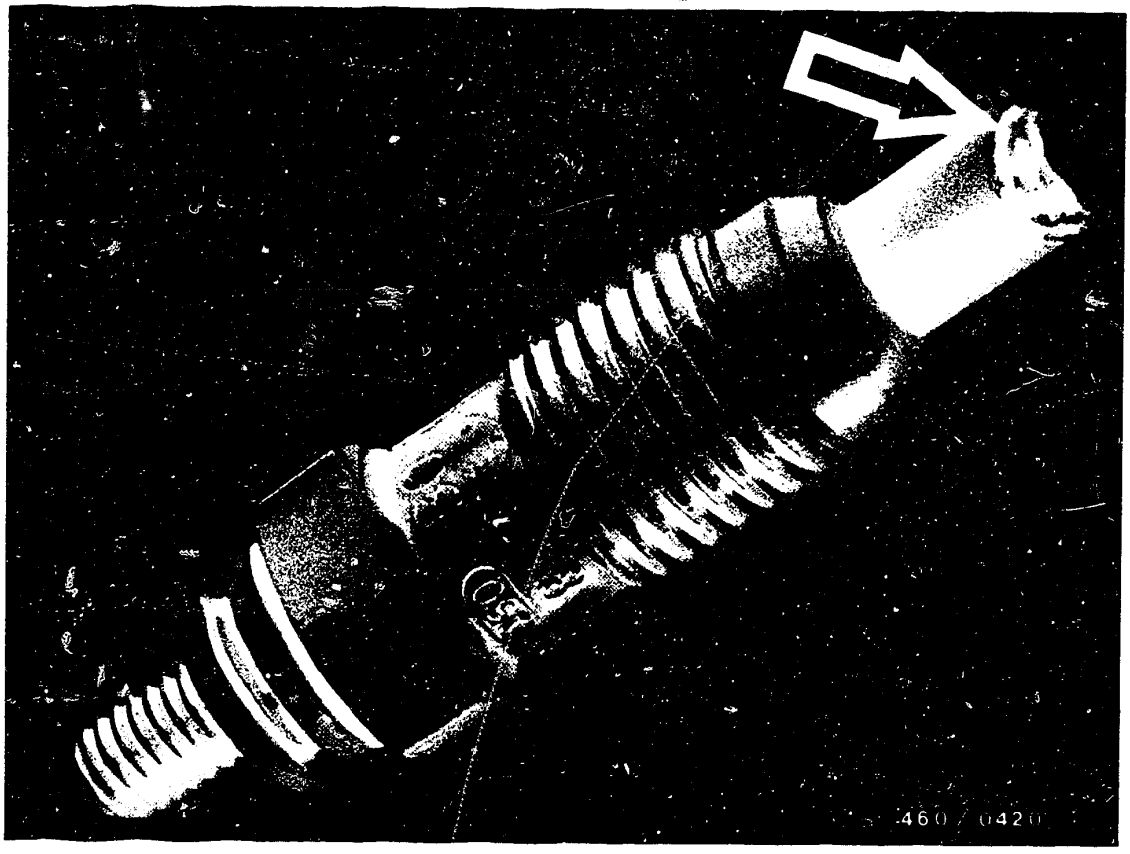


1 = Glow-duration unit
2 = Glow-plug indicator lamp
3 = Battery
4 = Starting motor
5 = Temperature sensor
6 = Fuses 80 A
7 = Solenoid-operated valve
8 = Glow plugs



1 = Glow-duration unit
2 = Glow-plug indicator lamp
3 = Battery
4 = Starting motor
5 = Temperature sensor
6 = Fuses 80 A
7 = Solenoid-operated valve
8 = Glow plugs

21.3 Terminal diagram for preheating system



Note:

Glow plugs with burned elements

Glow plugs with burned elements are frequently the result of troubles with the injection nozzle.

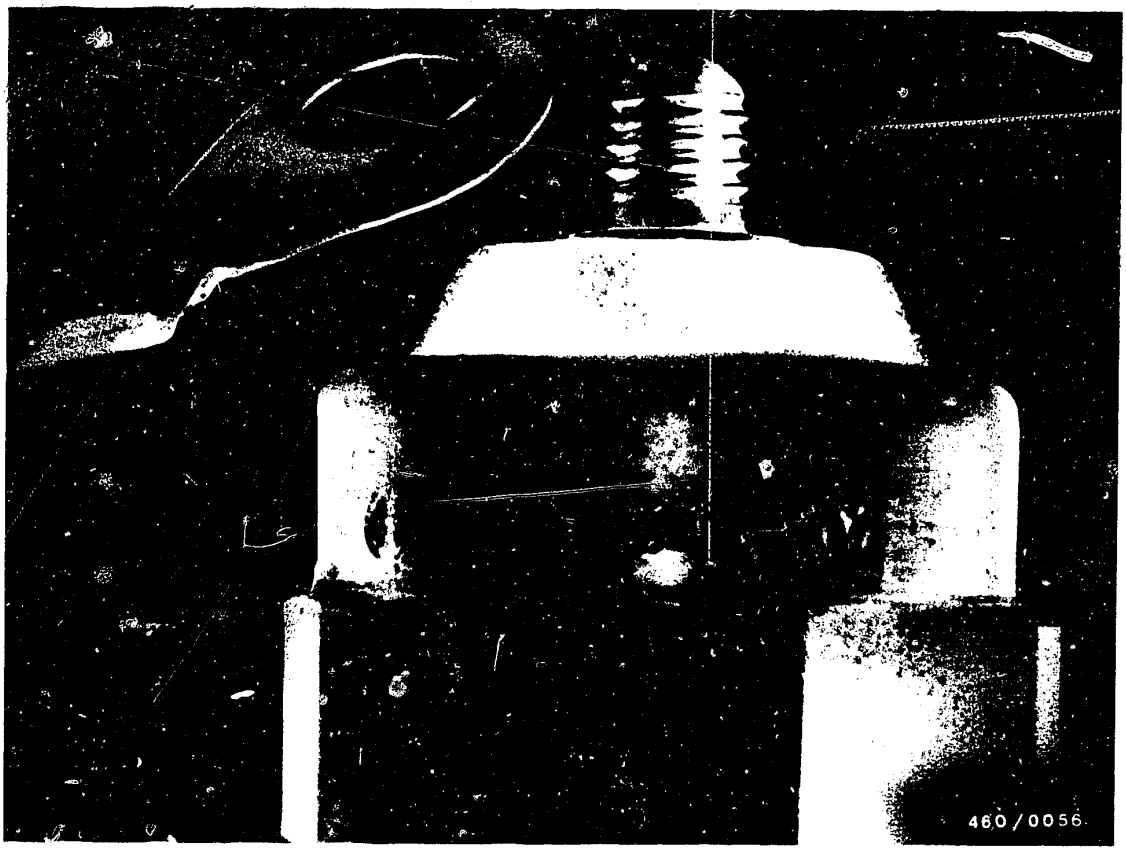
If glow plugs are found to have burned elements (arrow), it is not sufficient simply to replace them. The injection nozzles must also be tested for spray pattern, chattering, pressure and leaks.

22. Check timing device

In distributor-type fuel-injection pumps VE..F.. the timing device is integral with the fuel-injection pump.

In order to test the timing device, it is necessary to remove the fuel-injection pump.

Perform the test on the injection-pump test bench.



23. Measure engine compression and compression loss

23.1 Measure engine compression

Fit new chart in compression tracer. Mount high-pressure hose on tracer. Switch off engine.
In order to prevent fuel from being injected, remove connecting cable from shutoff magnet on distributor-type fuel-injection pump (picture).

Unscrew nozzle-holder assembly and use suitable connection nipple for compression tester.

Using the starting motor, turn over engine several times so that loose residues are removed from the compression space.

Screw in connection nipple.
(Ensure a good seal when screwing into the hole of the nozzle-holder assembly).

Mount high-pressure hose of compression tester on connection nipple.

During the following operation, note the first compression stroke.

Operate starting motor until there is no longer any detectable pressure rise on the compression tracer.

Bleed compression tracer by pressing on bleed valve.

The pointer returns to the starting position.

Move chart on to next position.

Mount connection nipple on following cylinders and repeat measurement.

Compression pressure: 28...34 bar

Allowable difference between cylinders: Max. 5 bar

23.2 Evalution of chart

1. Normal pressure rise

If piston rings and valves are in good condition, the first compression stroke shows the highest pressure increase.
During the following compression strokes the compression builds up to the maximum pressure.

2. Gradual pressure rise

If, from the start, the compression increases only gradually on each piston stroke, this points to burnt valve seats or defective valve guides.

3. Low maximum pressure

If the maximum pressure obtained is too low on all cylinders, this points to defective pistons, piston rings or valves.
If the compression is too low on two neighbouring cylinders, this points to a leaky cylinder head gasket.

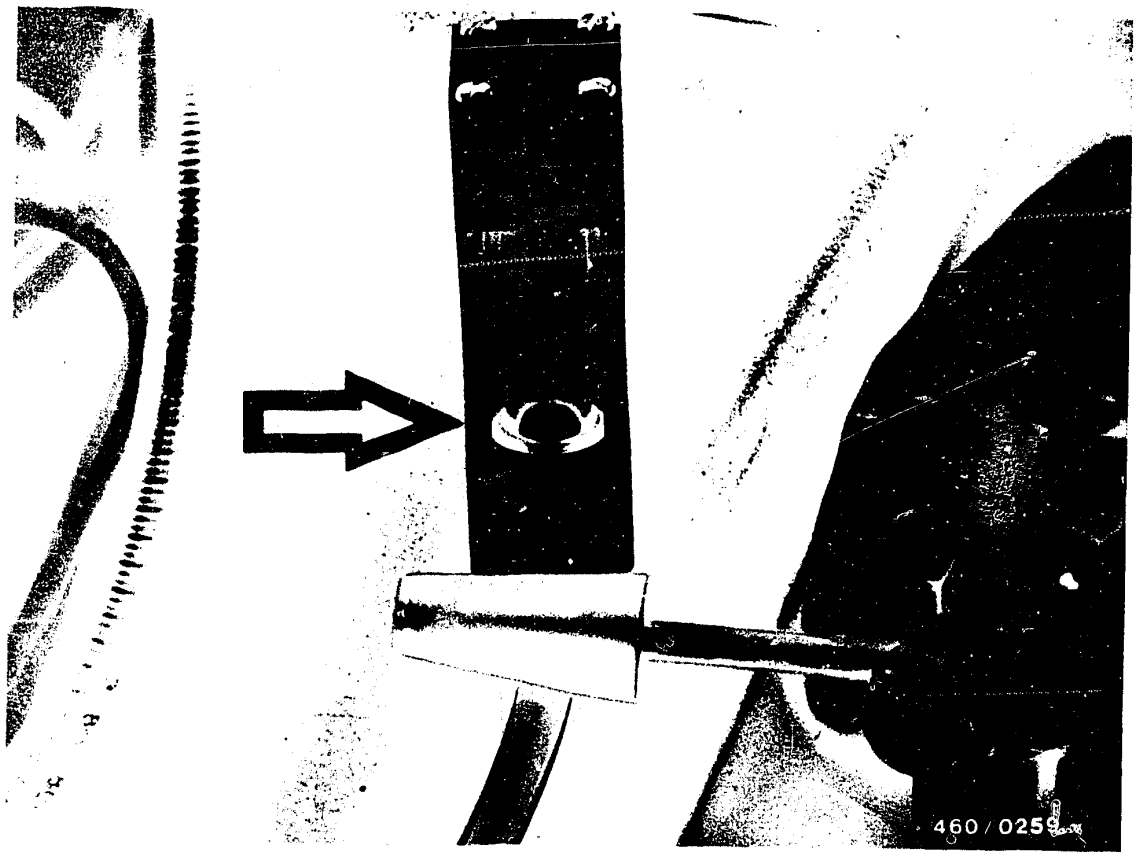
4. Varying compression

If one cylinder shows a clearly lower compression, proceed as follows: fill in 2-3 cm^3 of engine oil through the opening of the sheathed-element glow plug or nozzle-holder assembly and operate starting motor briefly.

Repeat measurements and compare charts. If there is a clear increase in compression during the second test, then the piston rings or cylinders are worn.
If there is no change in the result, then defective valves are the cause.

5. Uniform compression

Uniform compression is extremely important with regard to the smooth running of the engine. Maximum compression is, therefore, not the only objective.



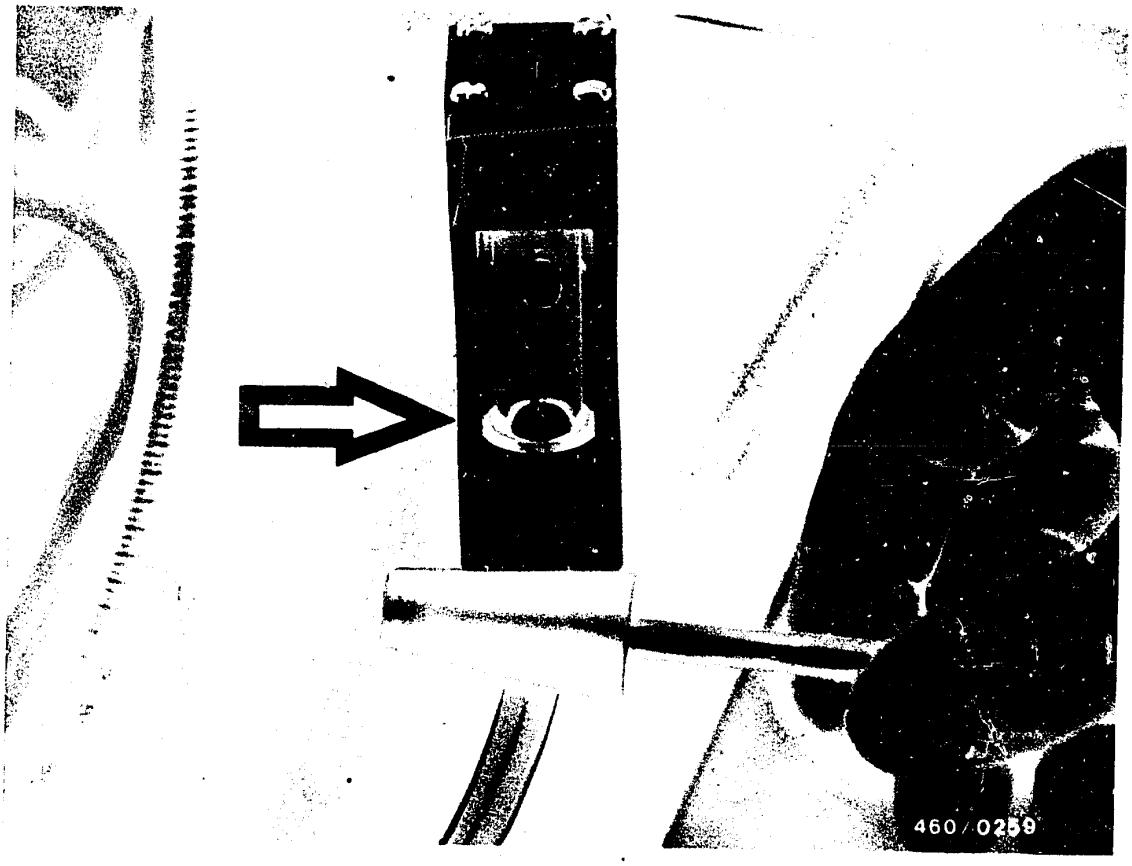
23.3 Measure compression loss of engine

The test is performed using the Bosch compression-loss tester 0 681 001 901 (EFAW 210 A).

For testing, the respective piston must be at TDC (TDC = top dead centre) on the compression stroke.

For setting this position, use DC detector 1 688 132 025 (included in accessories with compression-loss tester).

Perform test with engine at normal operating temperature (temperature of water approx. 80 °C).



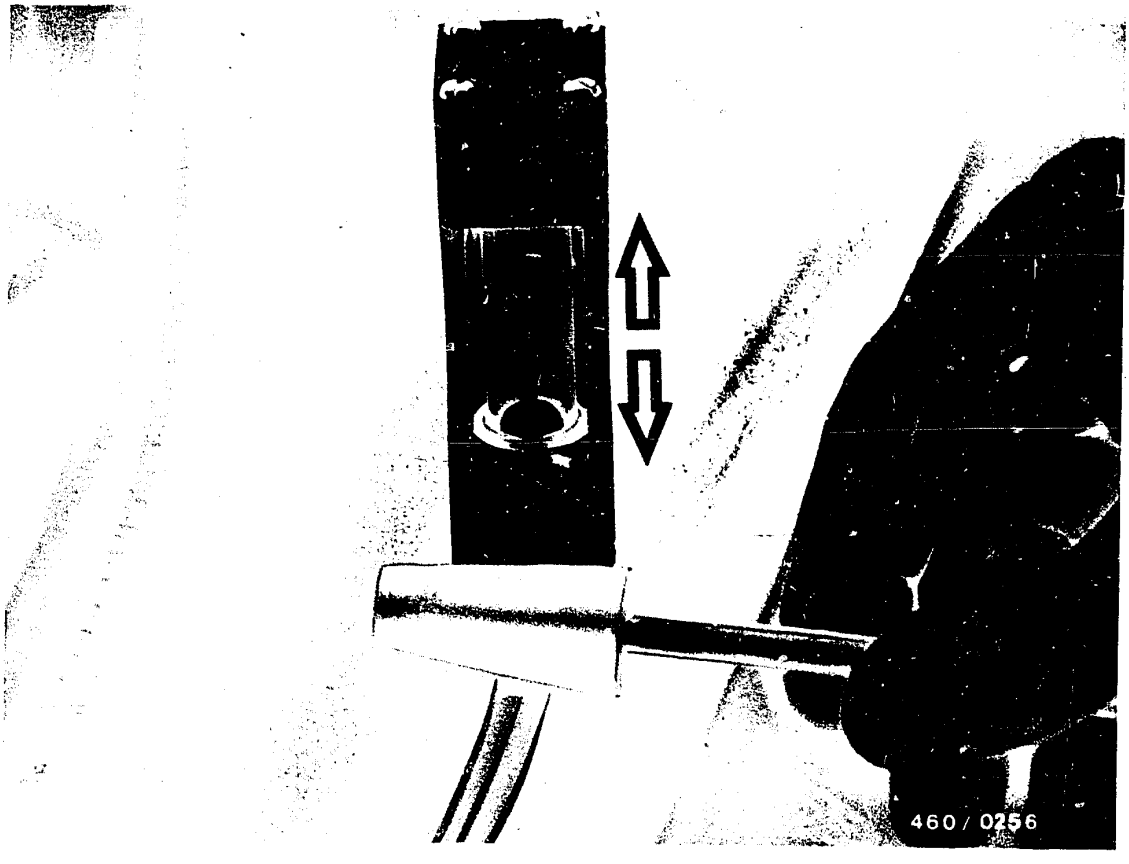
23.4 Set top dead centre

Remove sheathed-element glow plug from cylinder 1.

Insert rubber plug of DC detector into bore for sheathed-element glow plug.

Using magnetic clamp, mount glass cylinder in as vertical a position as possible in the engine compartment. The piston of the unit must be easily visible.

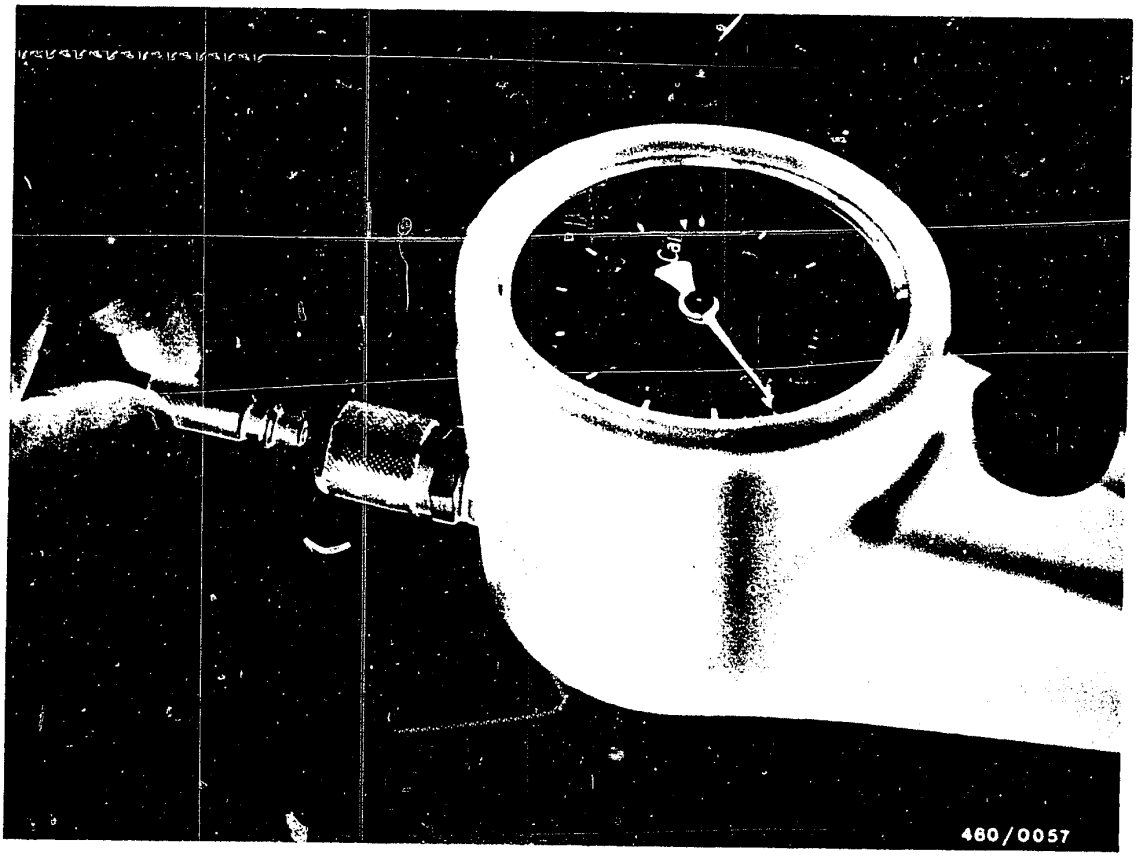
Slowly turn over engine crankshaft by hand in engine direction of rotation. (If necessary, select gear and push vehicle).



On the compression stroke, the piston of the DC detector is forced upwards.

As top dead centre is passed over, the piston slides down again immediately.

Locate top dead centre by carefully turning the engine backwards and forwards.



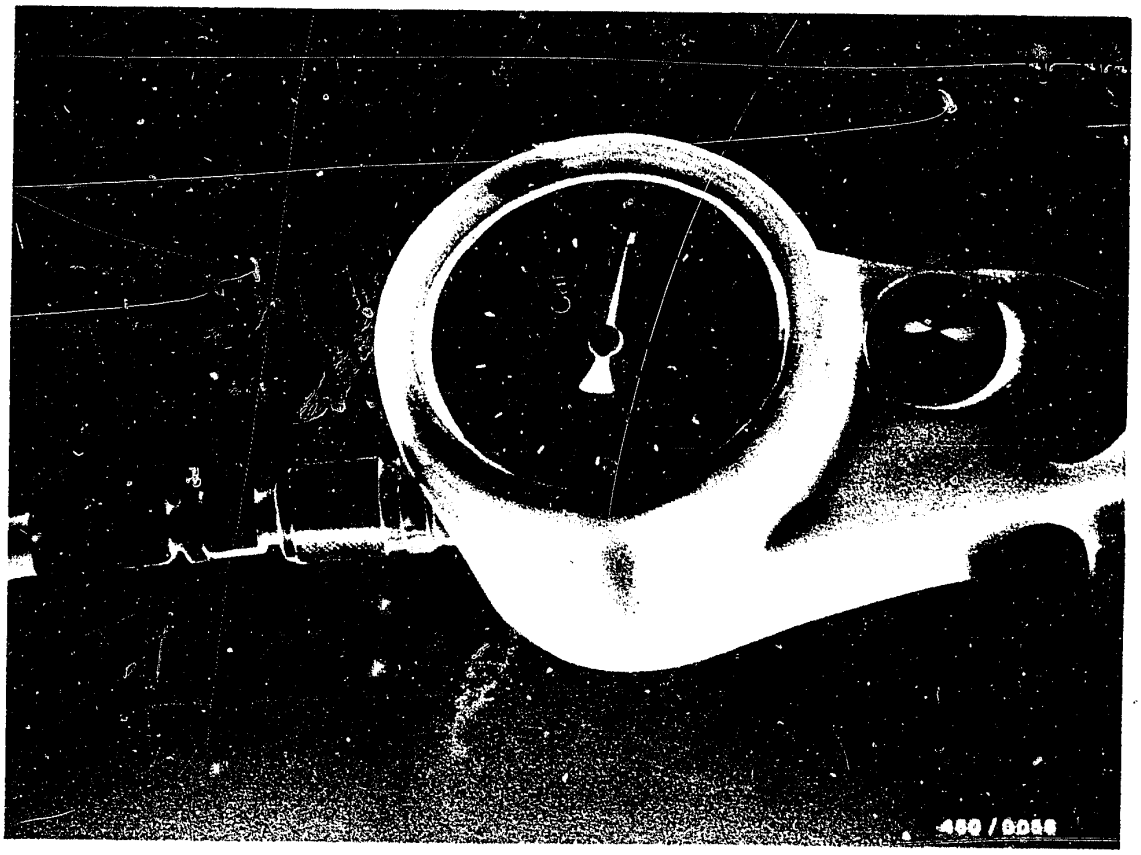
23.5 Measure compression loss

Connect tester to compressed-air mains.

Connect calibrating nozzle 1 680 363 036. Set a compression loss of 23 ± 1% (marking "Cal".) at the knurled thumbscrew on the pressure-regulation valve.

Remove test nozzle.

Instrument indicator must show approximately 0% compression loss - equipment check.



Screw in fitting and mount test hose.
Select gear and pull on handbrake.
Connect test hose to tester.
Read off compression loss in % on instrument.

Note:
Before testing the next cylinder, turn the engine over briefly without pre-heating using the starting motor so that the oil film re-forms.

23.6 Evalution of test

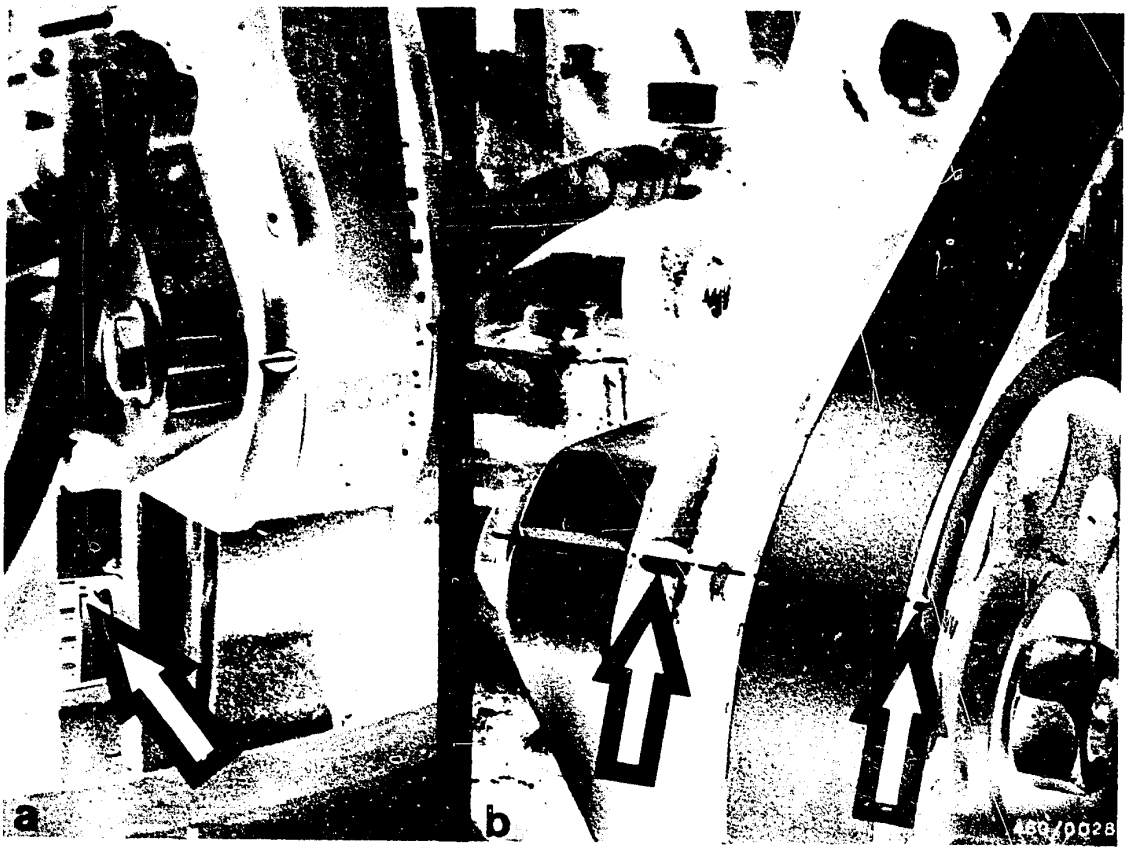
The compression loss indicated should not exceed 25%.

Differences of 10% between the individual cylinders can be ignored.
The causes of greater losses can be located because the air makes a noise as it escapes.
Listen at the following points:

Location of noise	Possible trouble
Intake manifold (remove air filter)	Intake valve
Exhaust manifold	Exhaust valve
Oil filler neck on engine	Pistons, piston rings
Cooling water filler neck (air bubbles)	Cylinder head gasket

In order to trace the trouble even more accurately, fill approximately 2-3 cm^3 of engine oil into the cylinder.
Repeat test.
If there is a clear decrease in compression loss during this test, then the fault lies with the piston or with the piston rings.

New engines which have not yet been run in (less than 5,000 km) may show higher compression losses than after the running-in period.



24. Remove fuel-injection pump

Disconnect negative cable from battery.

Remove coolant expansion tank and place to one side together with lines.

Remove air filter.
Remove toothed-belt guard for injection-pump drive.

Turn crankshaft to TDC on cylinder 1.

Marks on flywheel/clutch housing (Fig. a) and injection-pump gear/bracket (Fig. b) must be in alignment.

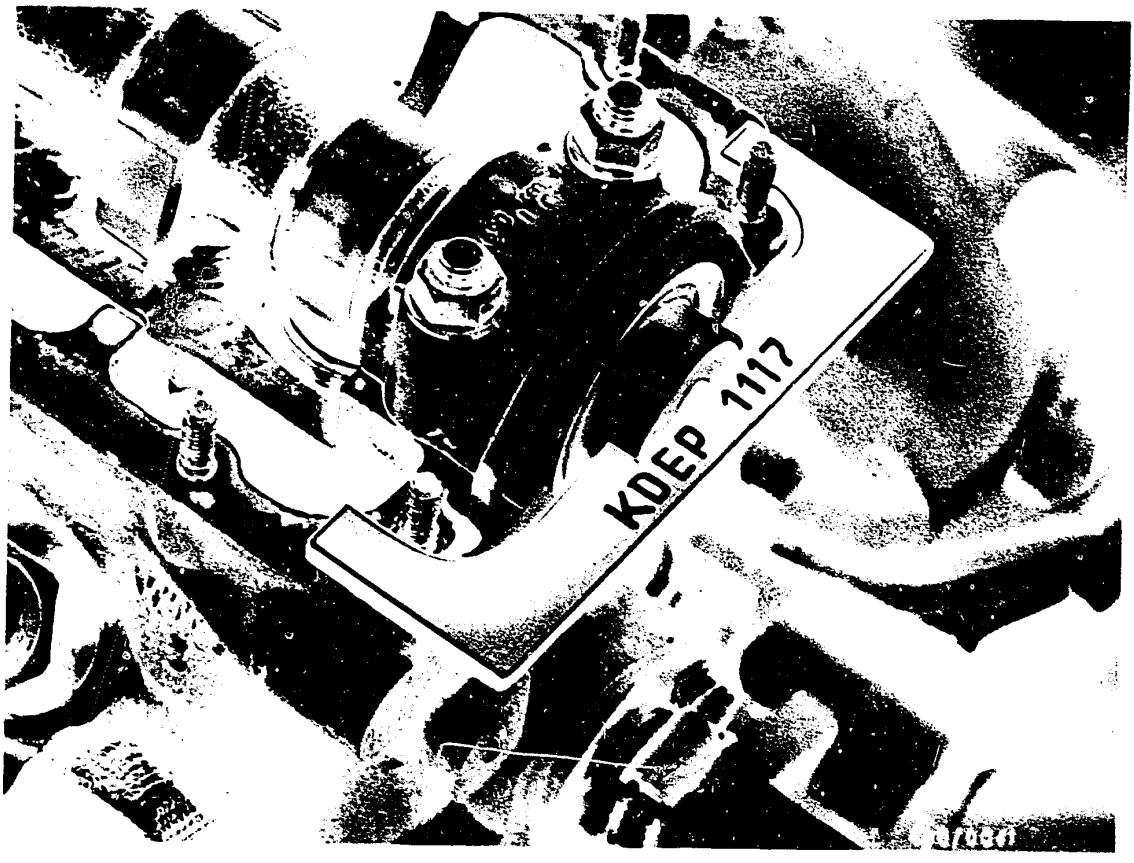
Lock injection-pump gear using setting mandrel KDEP 1122.

Loosen injection-pump gear fastening nut by one turn.

Hold camshaft gear with holder KDEP 1116.

Loosen and unscrew fastening screw (arrow).

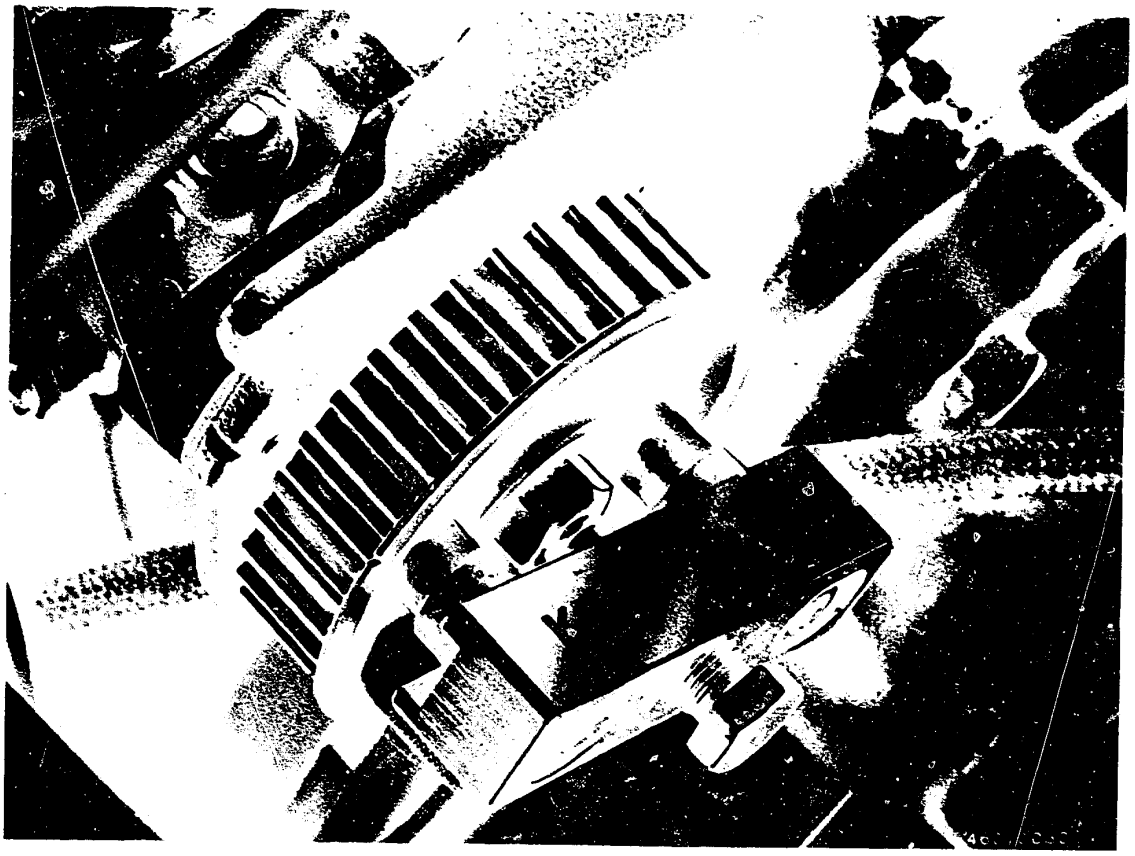
Remove camshaft gear with toothed belt.



Remove cylinder head cover.

Slide setting rule KDEP 1117 into camshaft recess.

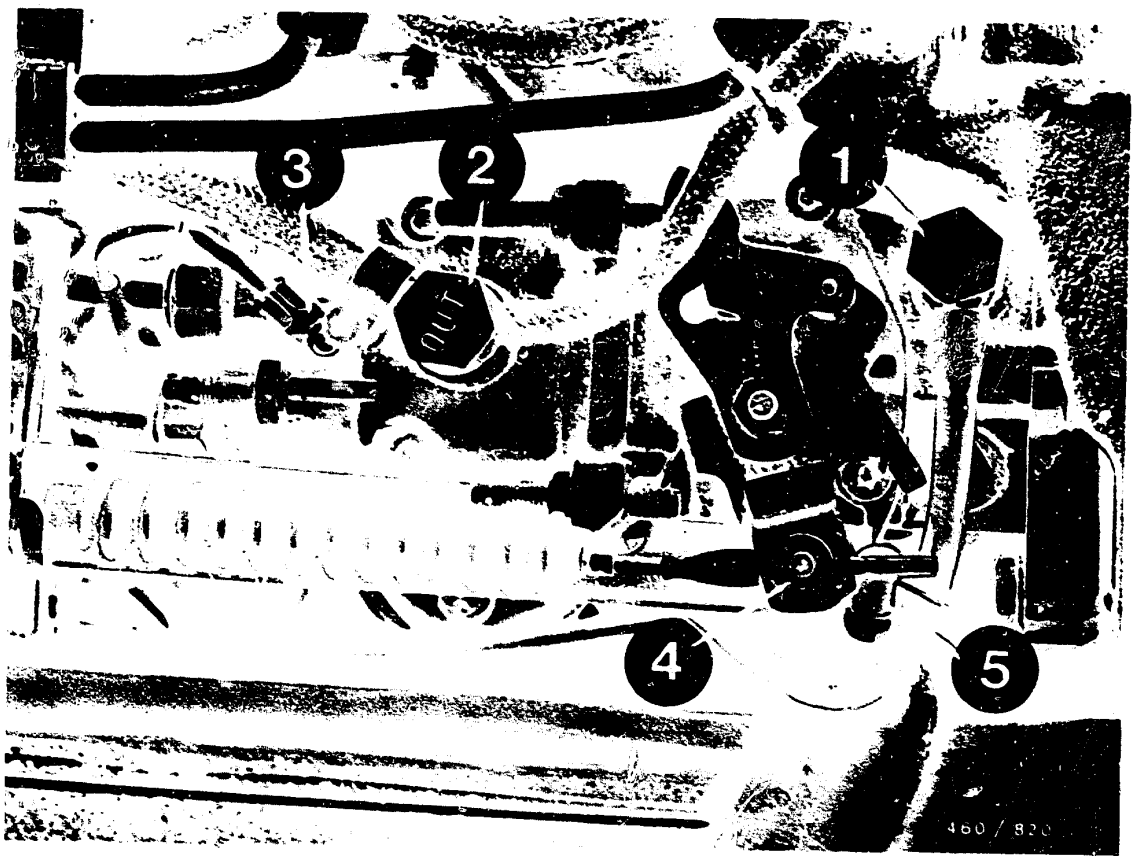
If it is not possible to introduce the setting rule, the engine timing must be corrected.



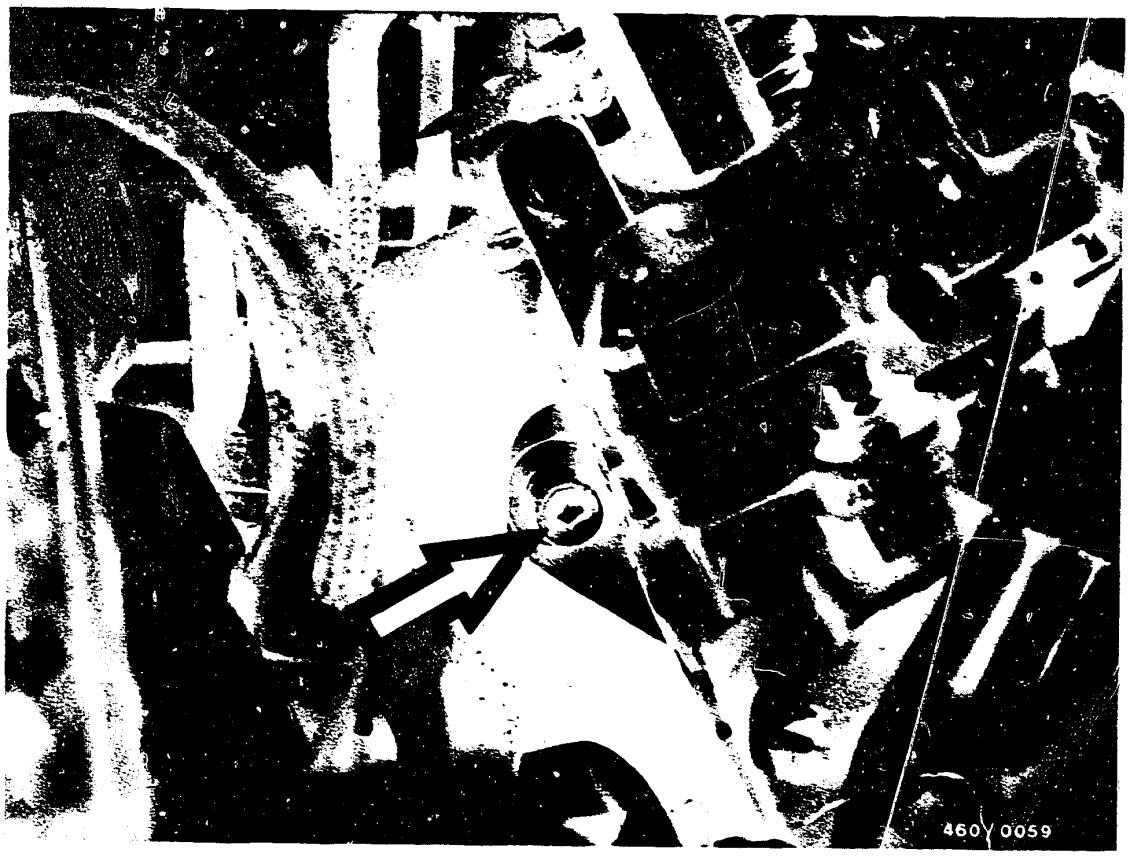
Mount puller KDEP 1118 on pump drive gear.

Remove pump drive gear.

Remove puller KDEP 1118. Unscrew fastening nut and remove injection-pump gear. Remove injection lines with box wrench KDEP 1115.
(Prevent delivery-valve holders from coming loose by holding with a wrench).

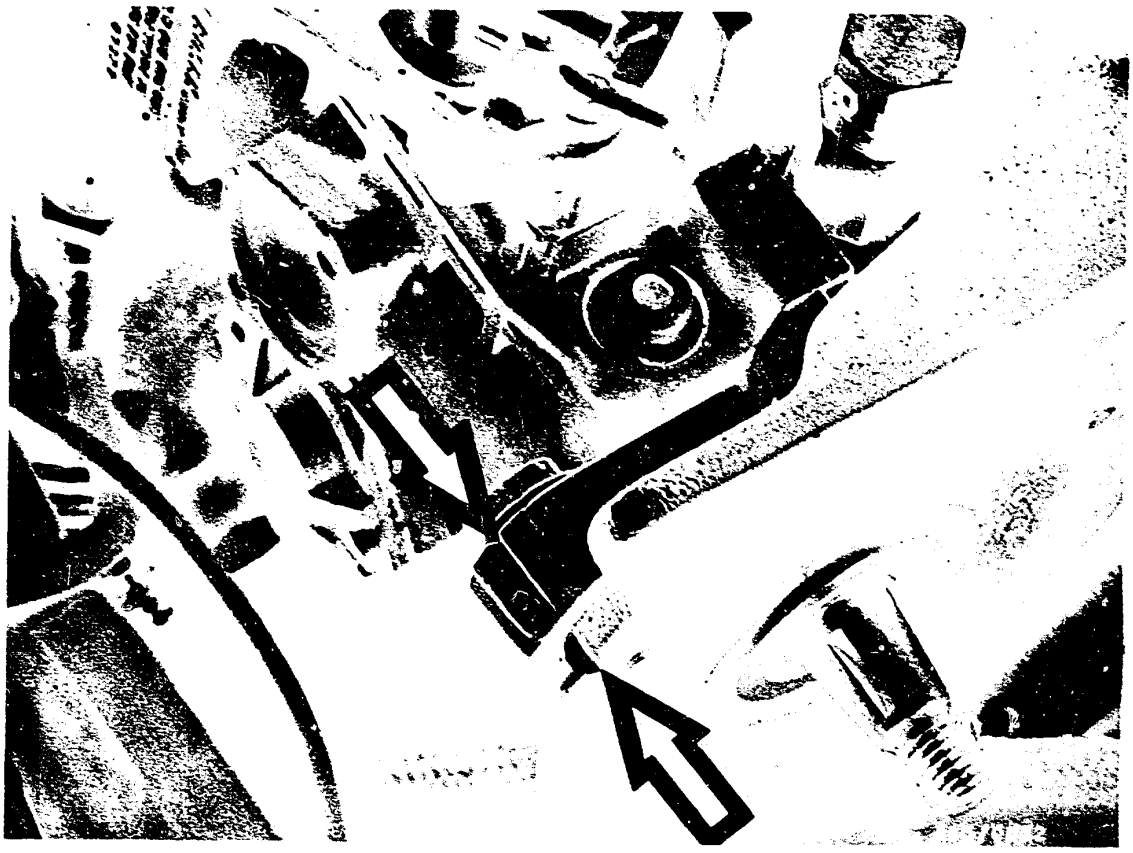


Remove fuel inlet line (1), return line (2), line of electric shutoff device (3), cable from accelerator on control lever (4) and cable for increased idle (5).



For the rear injection-pump fastening screw use socket (220 mm long for 6 mm hex. socket head).

Remove remaining fastening screws and remove distributor injection pump from engine.



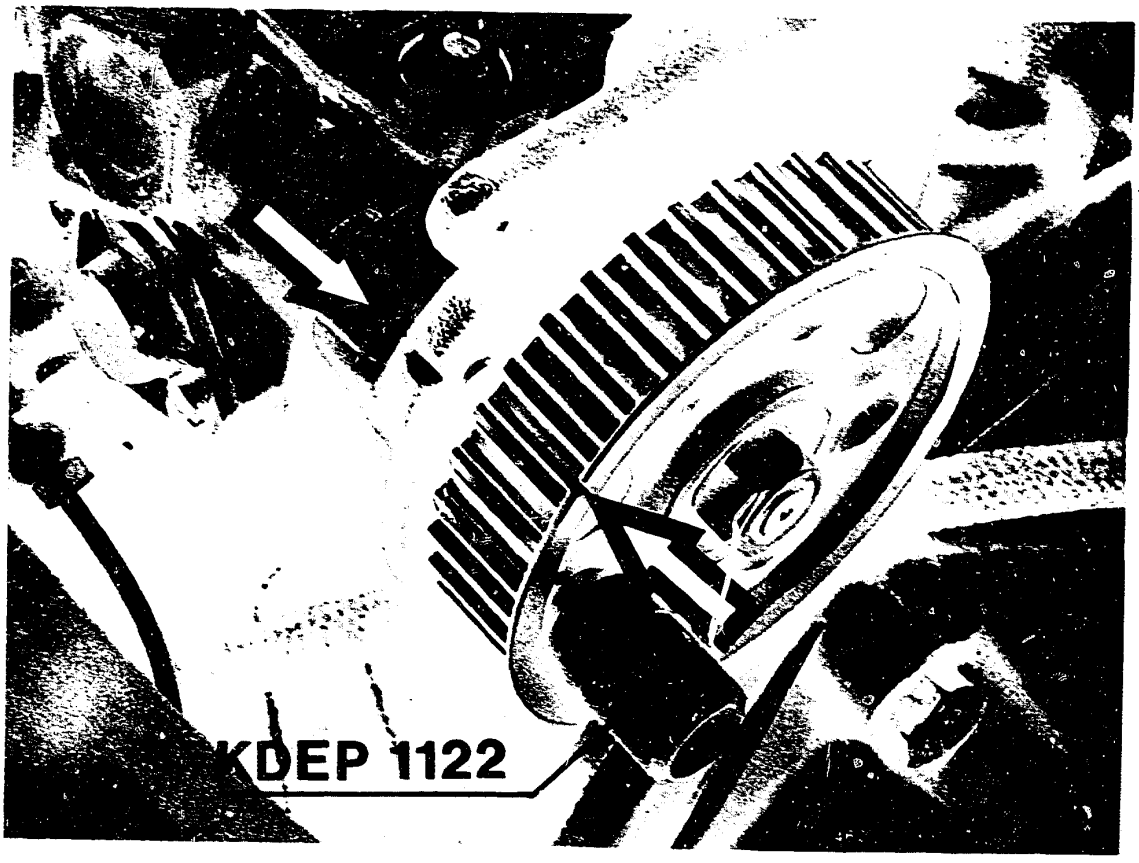
25. Install fuel-injection pump

Insert injection pump so that marks on injection-pump flange and bracket are in alignment (arrows).

Mount injection-pump fastening screws and finger-tighten.

Align support bracket on hydraulic head of injection pump so that it is up against the cylinder block and hydraulic head free of tension.

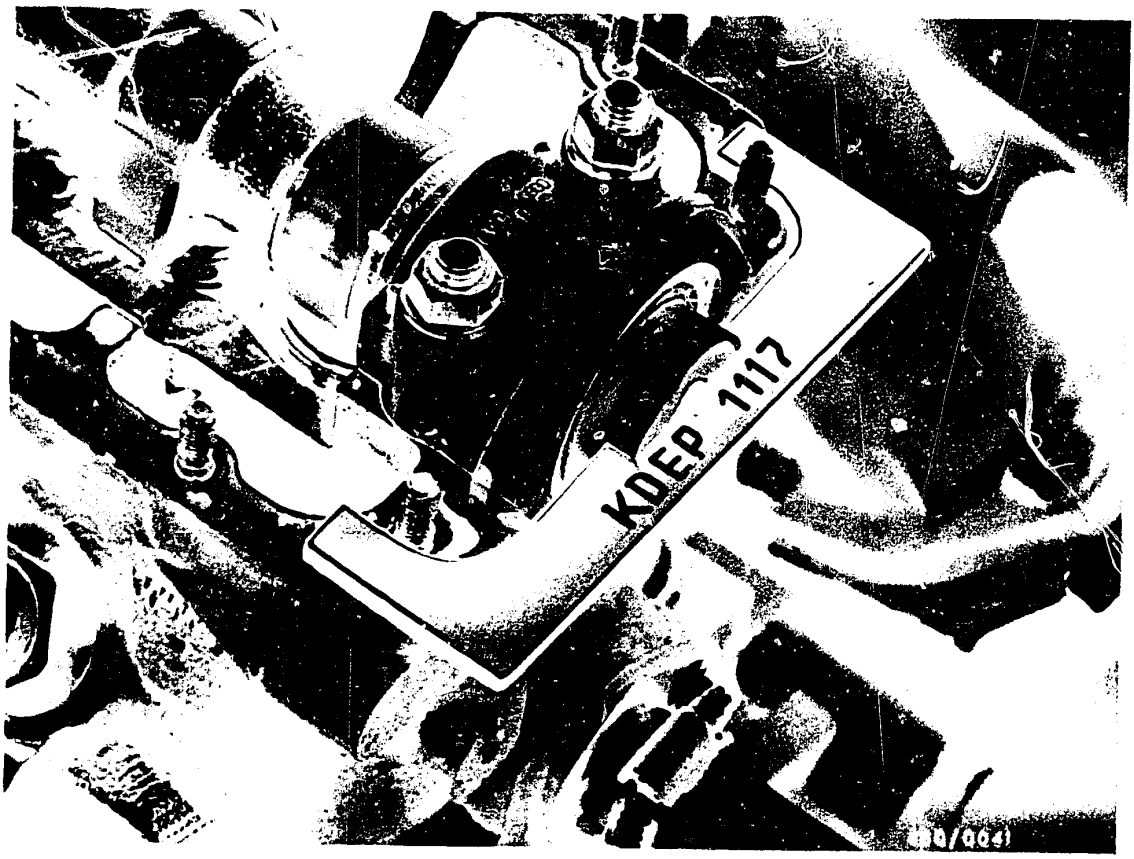
Screw down support bracket (arrow).



Mount injection-pump gear (Woodruff key in cone of pump drive shaft must be installed) and turn so that notch marks on injection-pump gear and bracket are in alignment (arrows).

Lock injection-pump gear with setting mandrel KDEP 1122.

Tighten fastening nut to 45 Nm.



Remove setting rule KDEP 1117.

Mount cylinder head cover.

Mount toothed belt with engine camshaft gear.

Tighten camshaft gear fastening screw (arrow) so that camshaft gear can still be turned by hand.

Remove setting mandrel KDEP 1122.

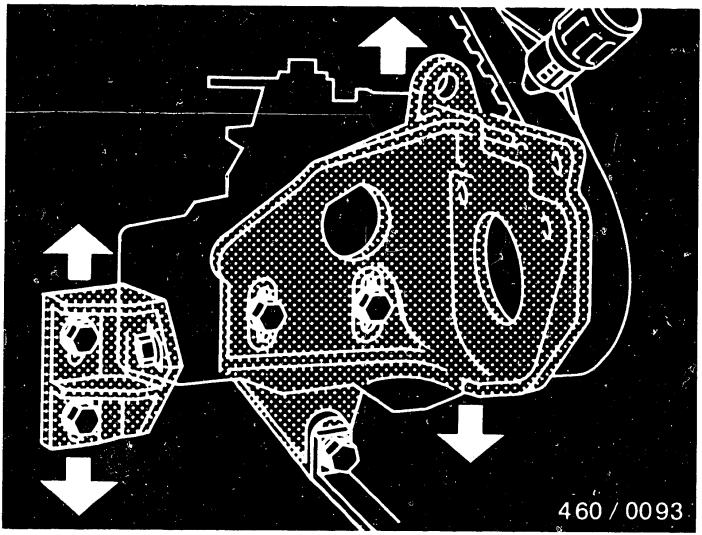
Test tension of toothed belt using belt tension tester KDEP 1121.

Mount belt tension tester as shown in the picture.

Turn vernier sleeve until bottom edge of sleeve aligns with the line mark on the measuring lug.

Make reading:

Set value: Scale value 12...13

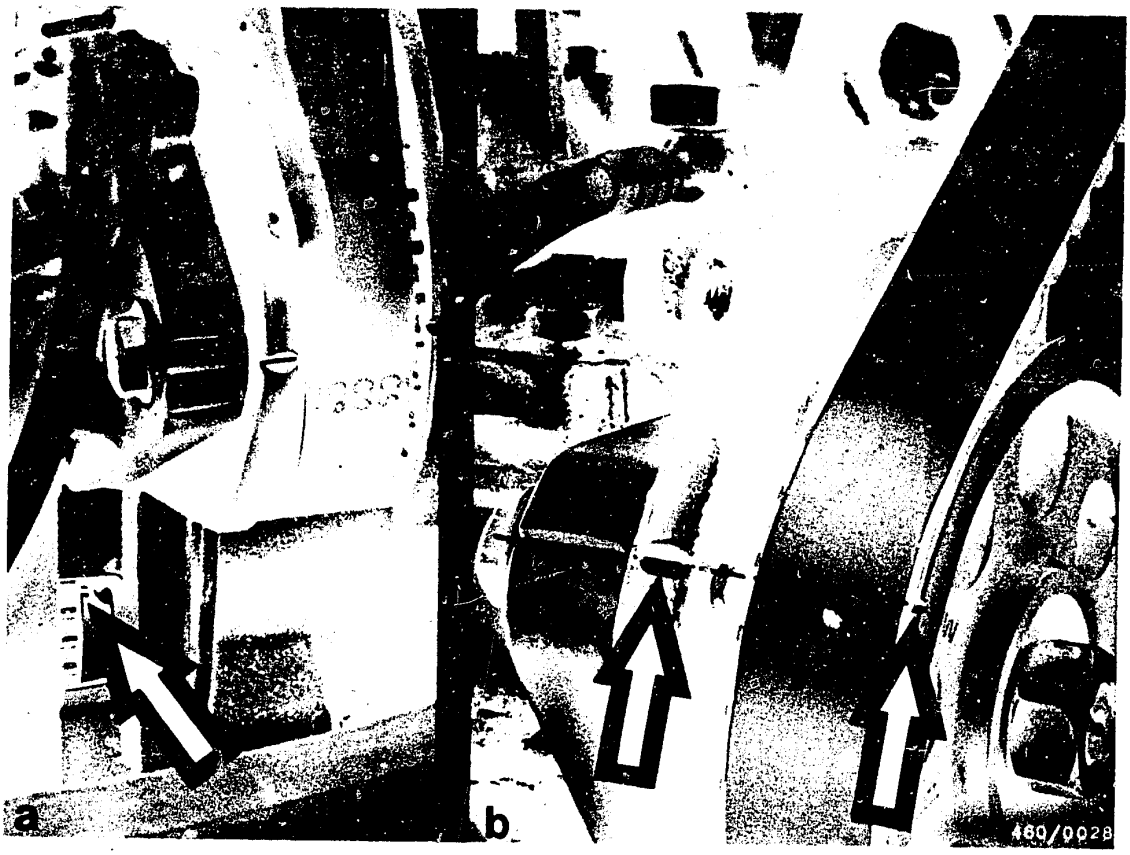


If the measured dimension differs from the set value, loosen fastening screws of pump bracket and of holding bracket on hydraulic head.

Move injection pump with bracket up or down as required (arrows).

Tighten fastening screws of pump bracket and of holding bracket to 65 Nm.

Turn engine crankshaft over twice and check tension of toothed belt again.

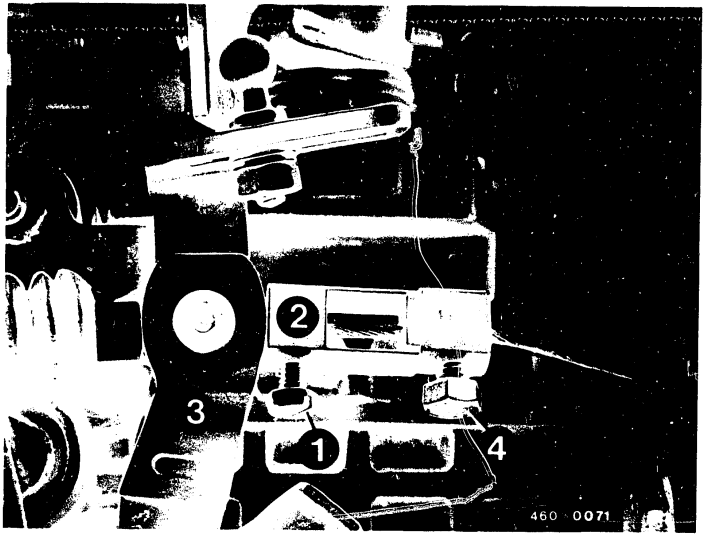


Check whether mark between flywheel and clutch housing (Fig. a) as well as between injection-pump gear and bracket aligns with reference mark (Fig. b).

Lock injection-pump gear with setting mandrel KDEP 1122.

Hold camshaft gear with holder KDEP 1116 and tighten fastening screw to 100 Nm.

Remove setting mandrel KDEP 1122.



When testing and adjusting the start of delivery, the temperature-controlled cold-start accelerator must be in the zero position.

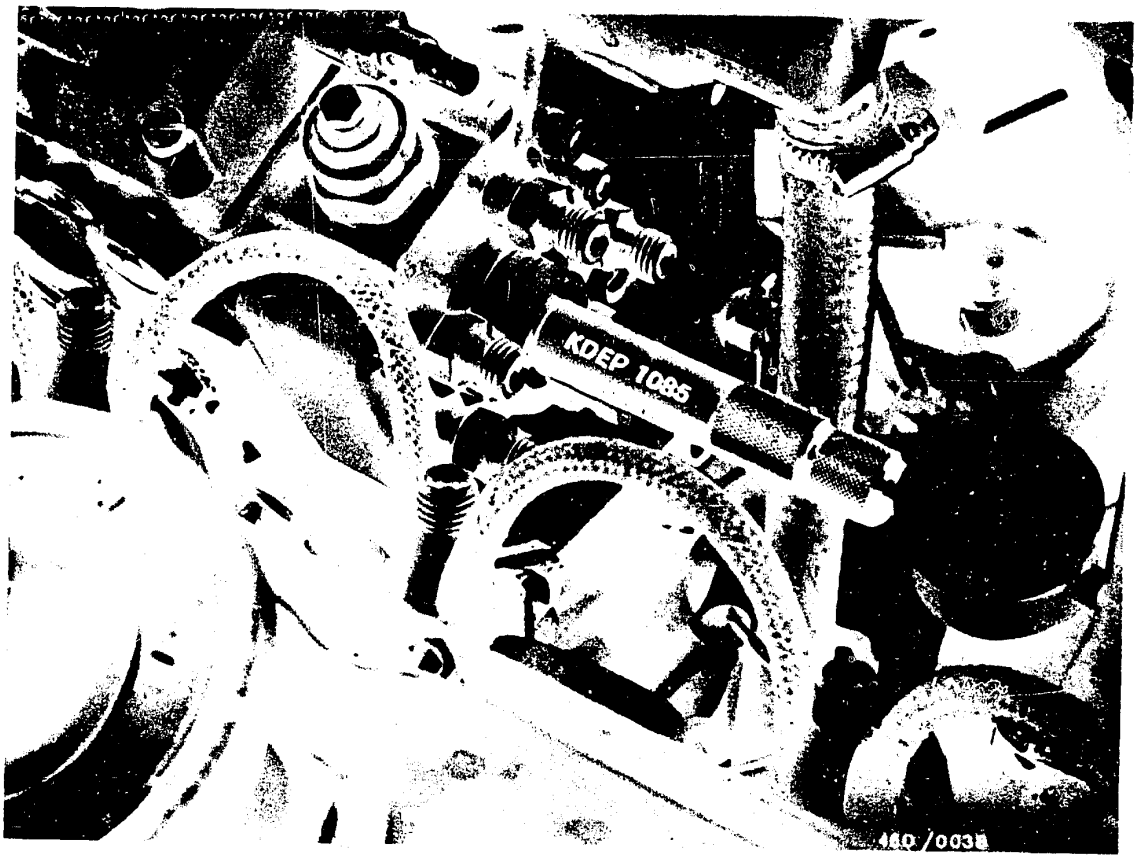
Loosen clamping screw (1) on injection pump.

Pull intermediate piece (2) with control lever (3) towards hydraulic head.

Turn intermediate piece (2) through 90° and push again toward drive shaft until control lever (3) is up against the stop bracket.

In this position, the control device is off.

Caution!
Locating screw (4) must not be loosened, since, otherwise, it will be necessary to reset the control device.



Unscrew bleeder screw out of central screw plug (triangular plug) of hydraulic head.

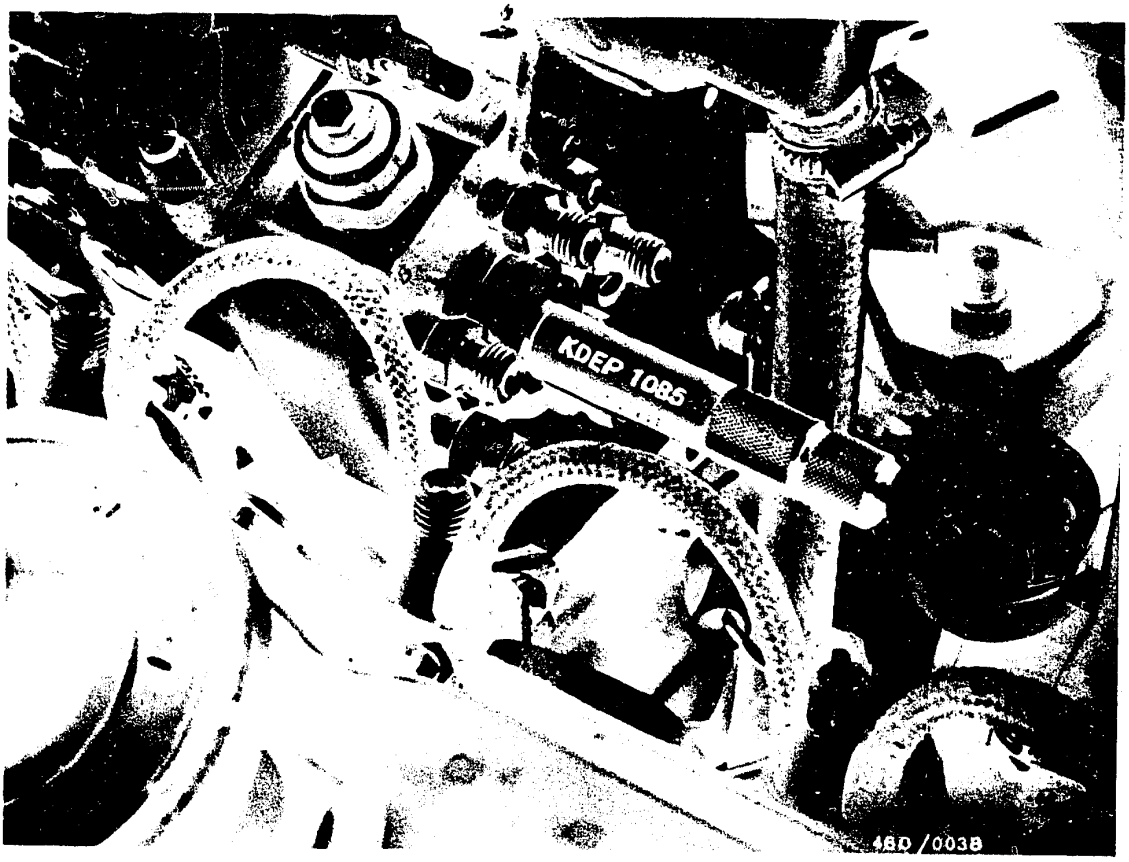
Mount measuring tool KDEP 1085 with dial indicator in tapped hole.

Preload dial indicator by approx. 2.5 mm.

Slowly turn crankshaft against engine direction of rotation until the pointer of the dial indicator no longer moves.

Preload dial indicator by approx. 1 mm and set to "0".

Set dial endicator to "0".



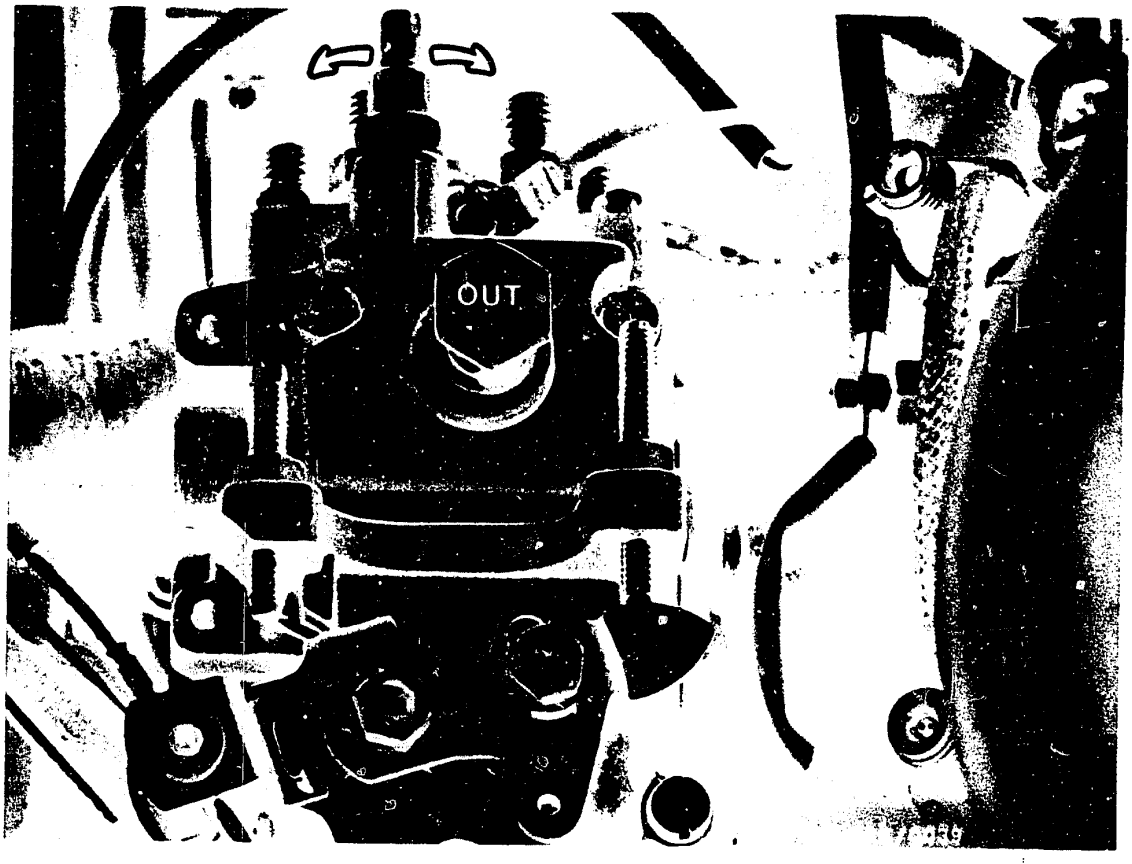
Turn crankshaft in engine direction of rotation until TDC mark on flywheel aligns with reference mark on clutch housing.

Check position of pump gear using setting mandrel KDEP 1122.

The dial indicator must show one of the following values as setting dimension:

Pump position 0,97 mm after BDC (9.78 - 11.82)

Pump position 0,80 mm after BDC (12.82 →)



If a correction is necessary, loosen injection-pump fastening screws and set the respective stroke by pivoting.

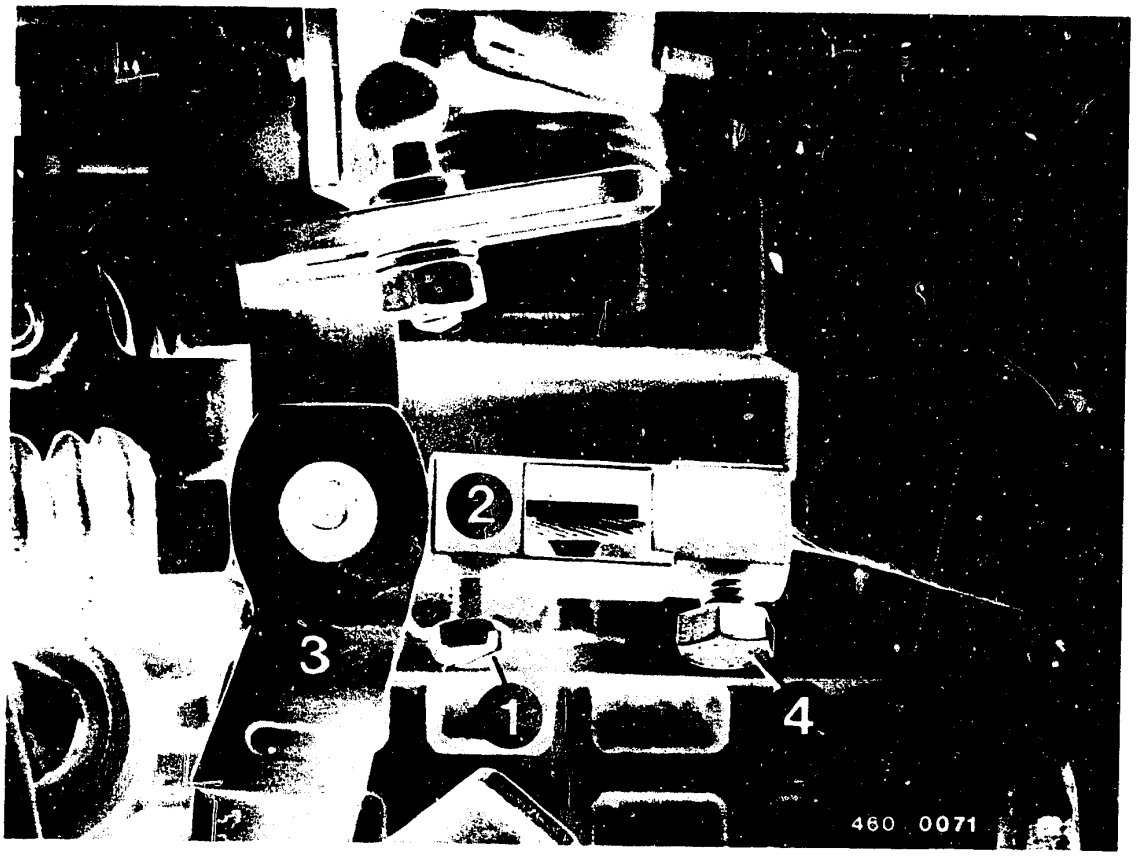
Setting values:

Pump position 0,97 mm after BDC (9.78 - 11.82)

Pump position 0,80 mm after BDC (12.82 →)

Tighten fastening screws to 25 Nm.
Turn crankshaft over twice and check setting.

Remove measuring tool KDEP 1085 with dial indicator.
Mount bleeder screw with new seal ring.



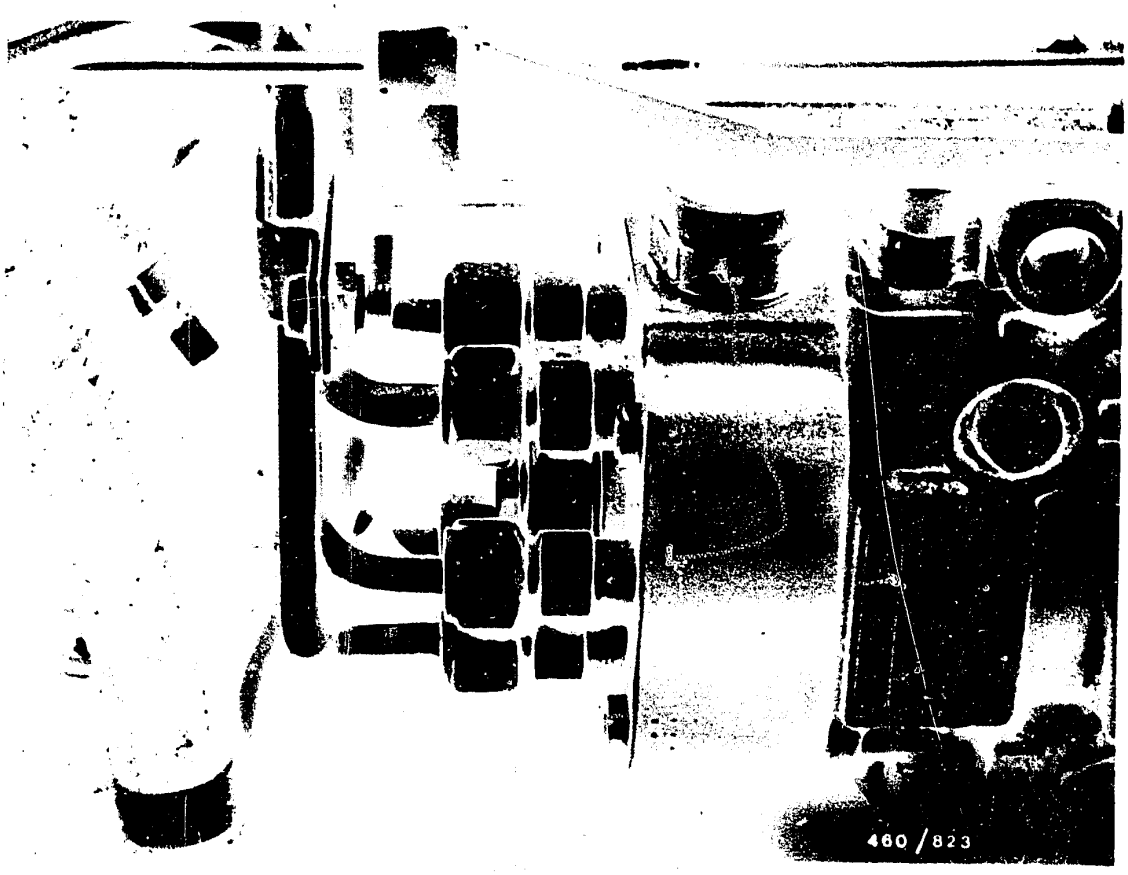
Pull control lever (3) with intermediate piece (2) toward hydraulic head.

Turn intermediate piece (2) through 90° and push again toward drive shaft.

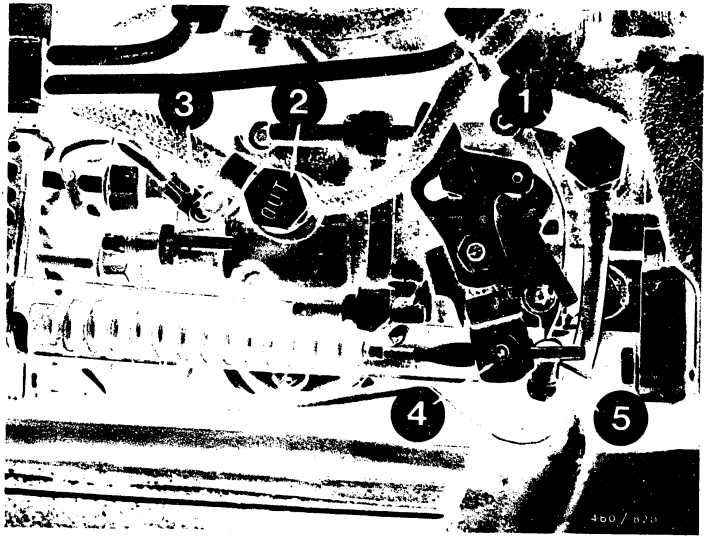
Intermediate piece is in starting position.

Tighten clamping screw (1).

Caution!
Locating screw (4) must not be loosened, since, otherwise, it will be necessary to reset the control device.



Tighten injection lines with box wrench KDEP 1115 (prevent delivery-valve holders from turning by holding with a wrench).

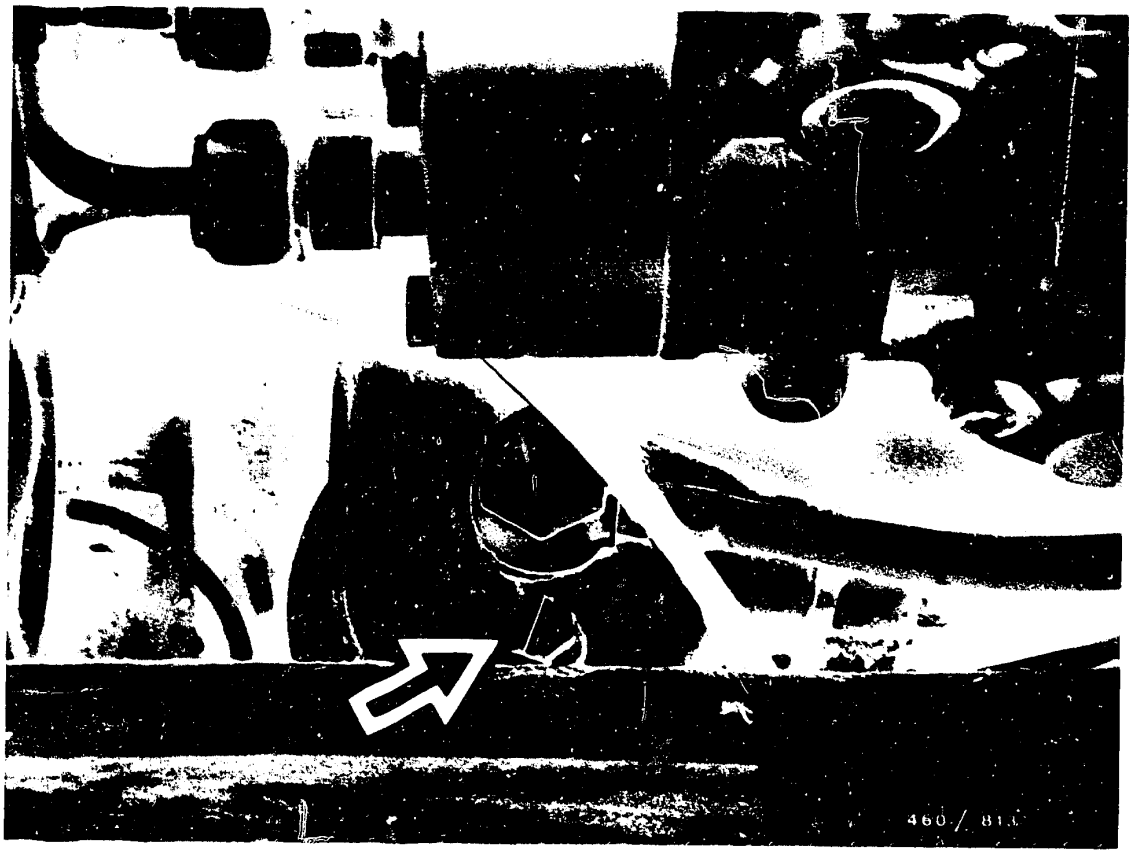


Mount fuel inlet line (1), return line (2), line of electric shutoff device (3), cable from accelerator to control lever (4) and cable for increased idle (5).

Note:

The inlet-union screws of the fuel inlet and return lines must not be mixed up.
The inlet-union screw of the return line is provided with restriction bores and the head of the screw is marked with the word "OUT".

Connect negative cable to battery.



25.1 Bleed fuel system

Fill fuel filter and injection pump with diesel fuel.

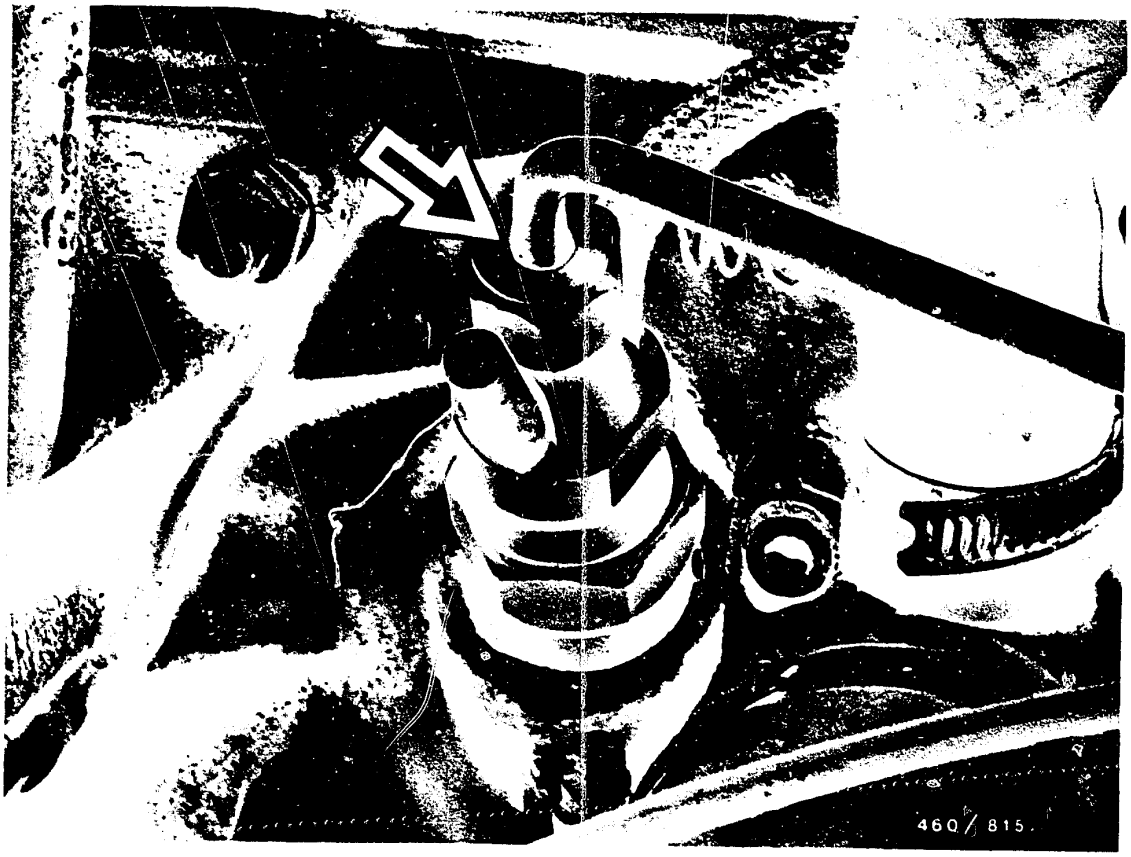
Tighten hose connections on filter cover.

If fitted, close bleeder screw on fuel filter (arrow).

Loosen bleeder screw on injection pump and unscrew by a few turns (arrow).

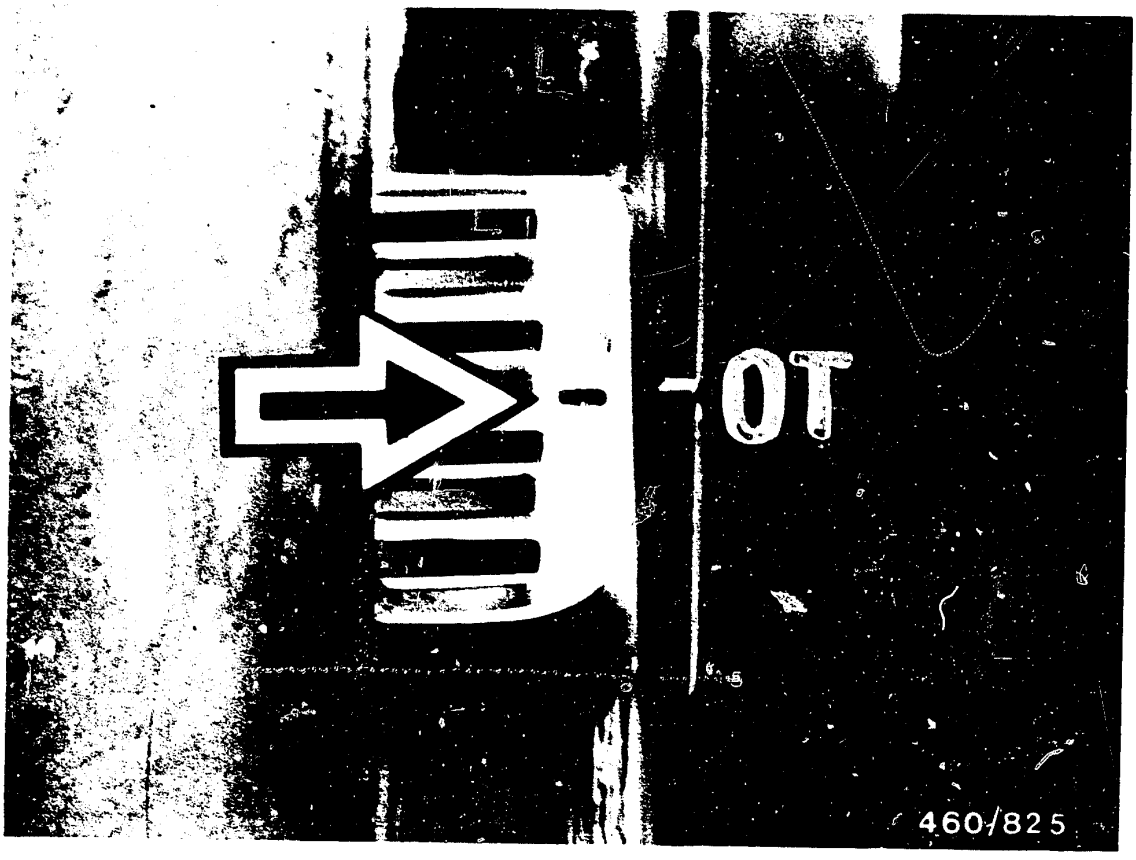
Loosen union nuts of fuel-injection tubing on nozzle holders.

Operate starting motor without preheating.
When the fuel escaping from the bleed hole on the injection pump is free of bubbles, retighten the bleeder screw.



Continue to operate starting motor until fuel escapes from union nuts of nozzle holders (arrow).

Tighten union nuts and operate starting motor until engine starts.



26. Test and adjust engine timing

26.1 Test engine timing

Remove coolant expansion tank and place to one side together with lines.

Remove air filter, cylinder head cover and toothed-belt guard for injection pump.

Turn crankshaft to TDC on cylinder 1 (cylinder 6 on valve overlap).

The mark on the flywheel and the reference mark on the clutch housing must align (arrow).

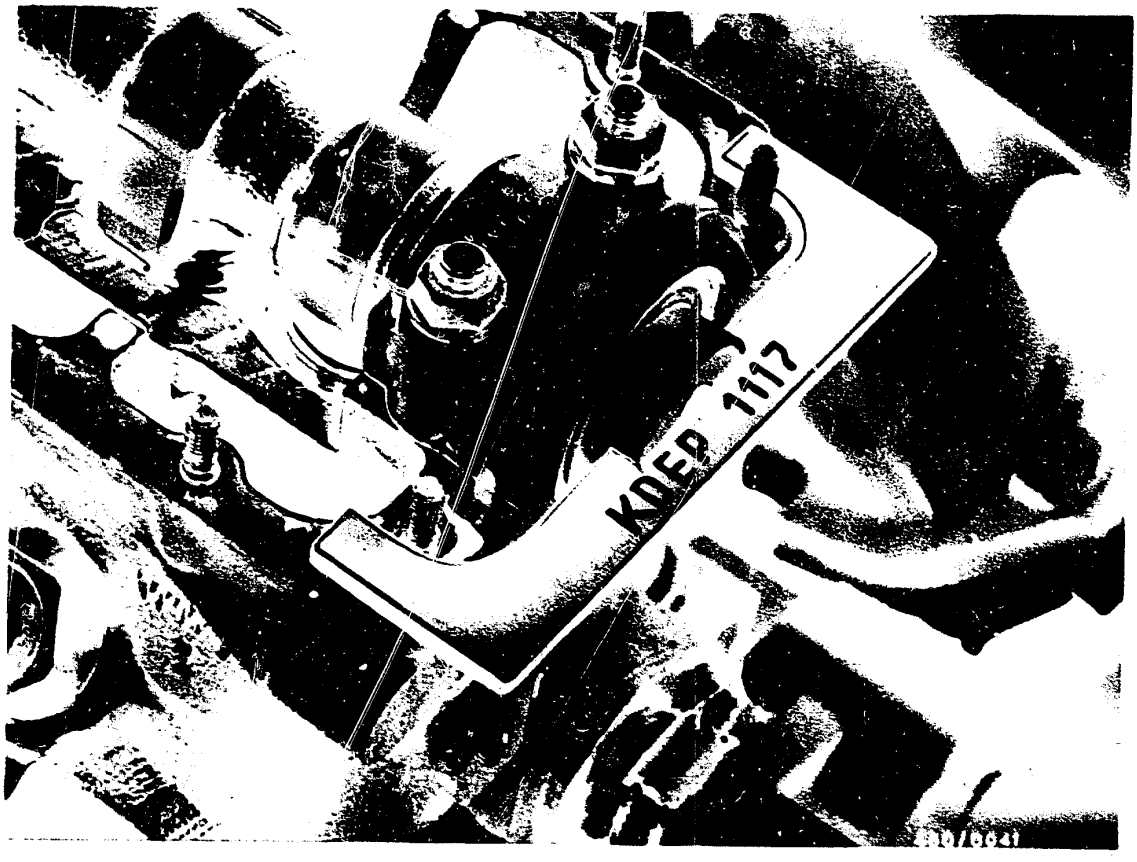
Lock injection-pump gear using setting mandrel KDEP 1122.

Lock camshaft gear with holder KDEP 1116.

Loosen camshaft gear fastening screw (arrow) and unscrew.

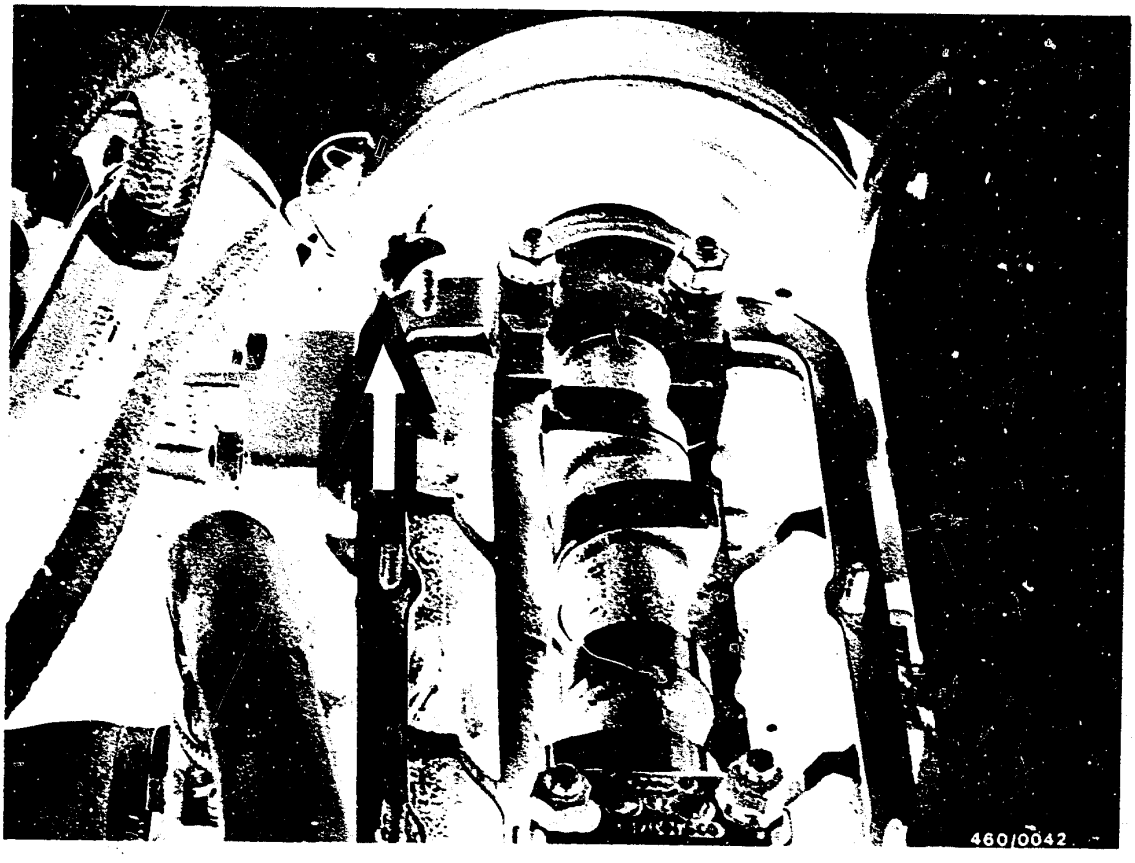
Remove camshaft gear with toothed belt.

Check TDC position on flywheel.



Slide setting rule KDEP 1117 into camshaft recess.

If setting rule cannot be introduced, the engine timing must be corrected.



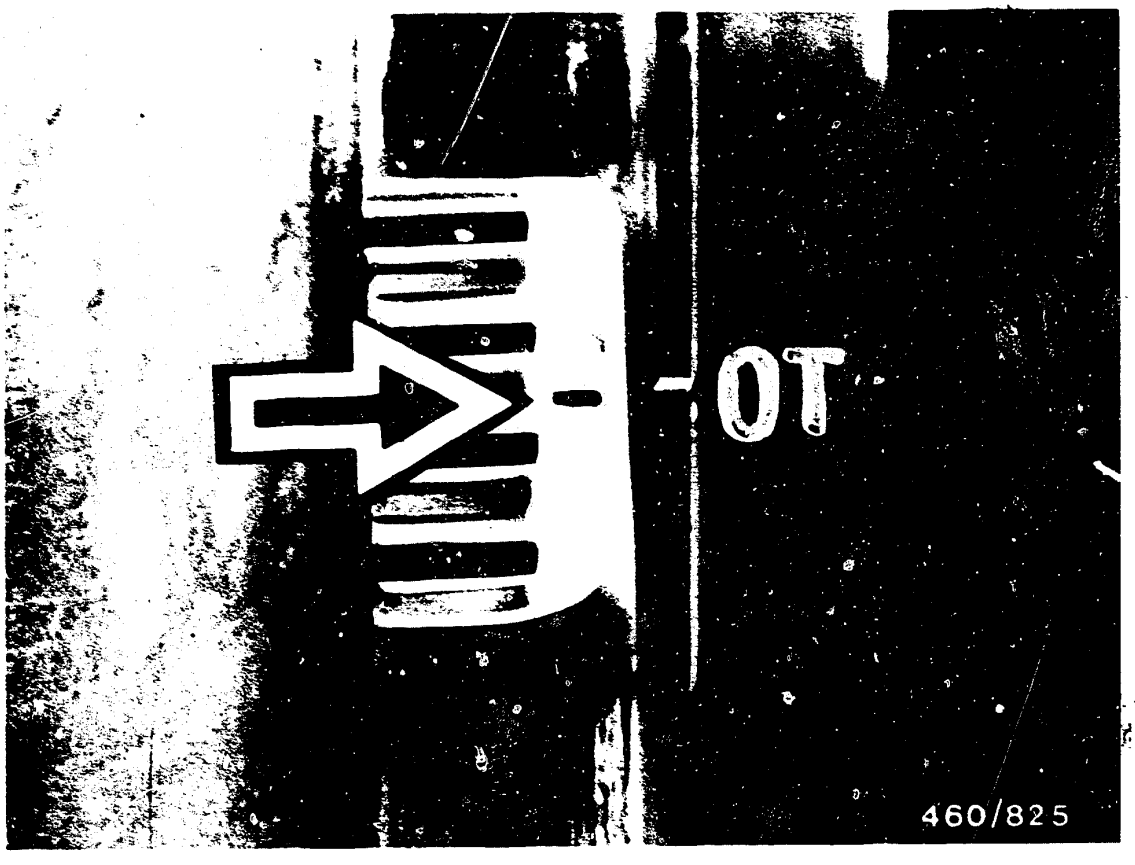
25.2 Adjust engine timing

Turn crankshaft until setting rule can be introduced.

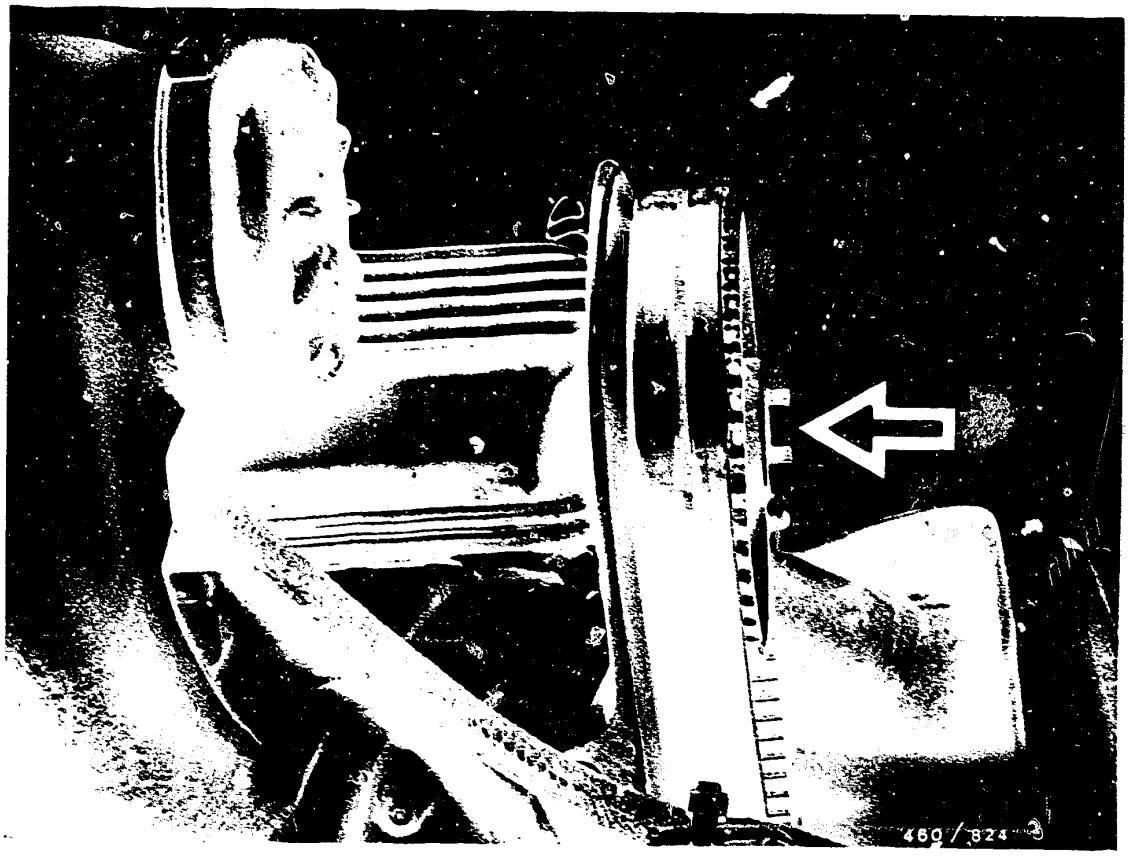
Remove toothed-belt guard for camshaft drive.

Loosen camshaft drive gear fastening screw by one turn.

Loosen camshaft drive gear from camshaft by tapping with a hammer.
To do this, guide mandrel through opening in cover plate (arrow).



Turn crankshaft in direction of rotation until TDC mark on clutch housing aligns with reference mark on flywheel.



Tighten camshaft drive gear (arrow) in this position to 45 Nm.

Remove setting rule KDEP 1117.

Mount toothed-belt guard and cylinder head cover.

Mount toothed belt with camshaft gear of engine.

Tighten fastening screw (arrow) by hand so that camshaft gear can still be moved.

Remove setting mandrel KDEP 1122.

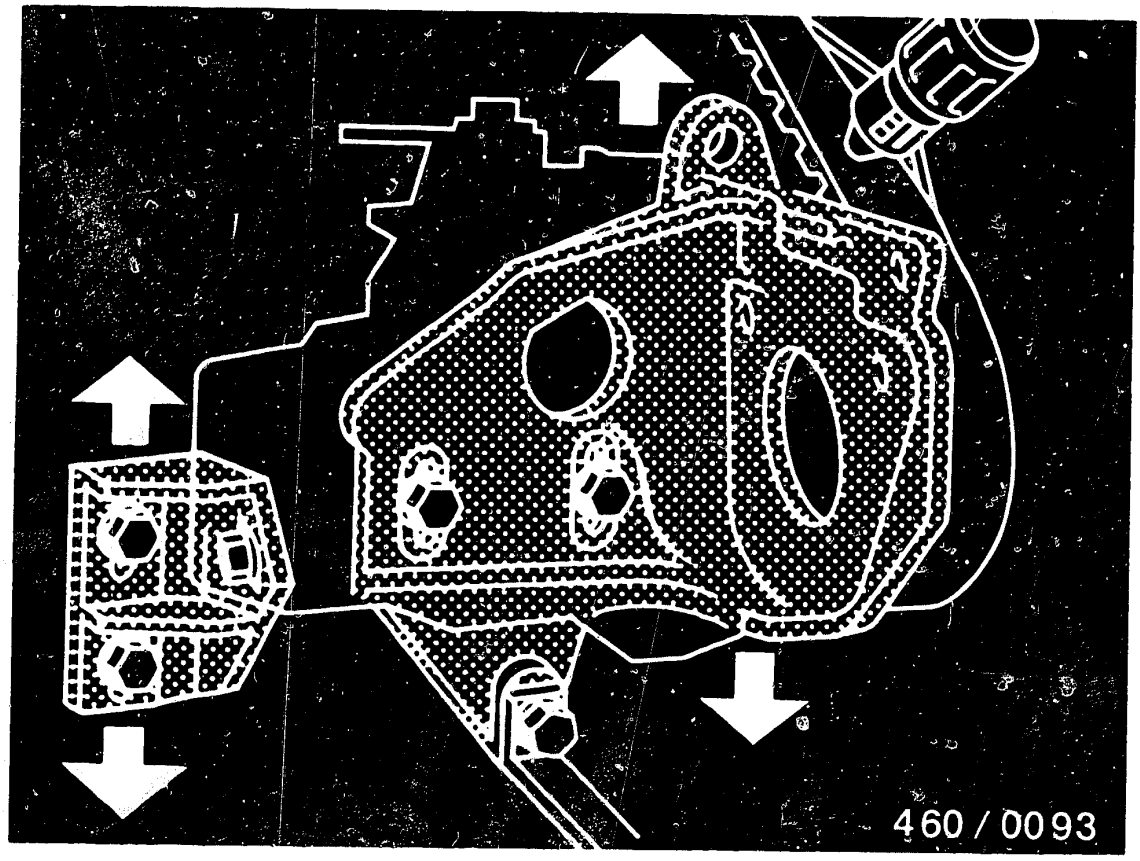
Test tension of toothed belt using belt tension tester KDEP 1121.

Mount belt tension tester as shown in the picture.

Turn vernier sleeve until bottom edge of sleeve aligns with the line mark on the measuring lug.

Make reading:

Set value: Scale value 12...13

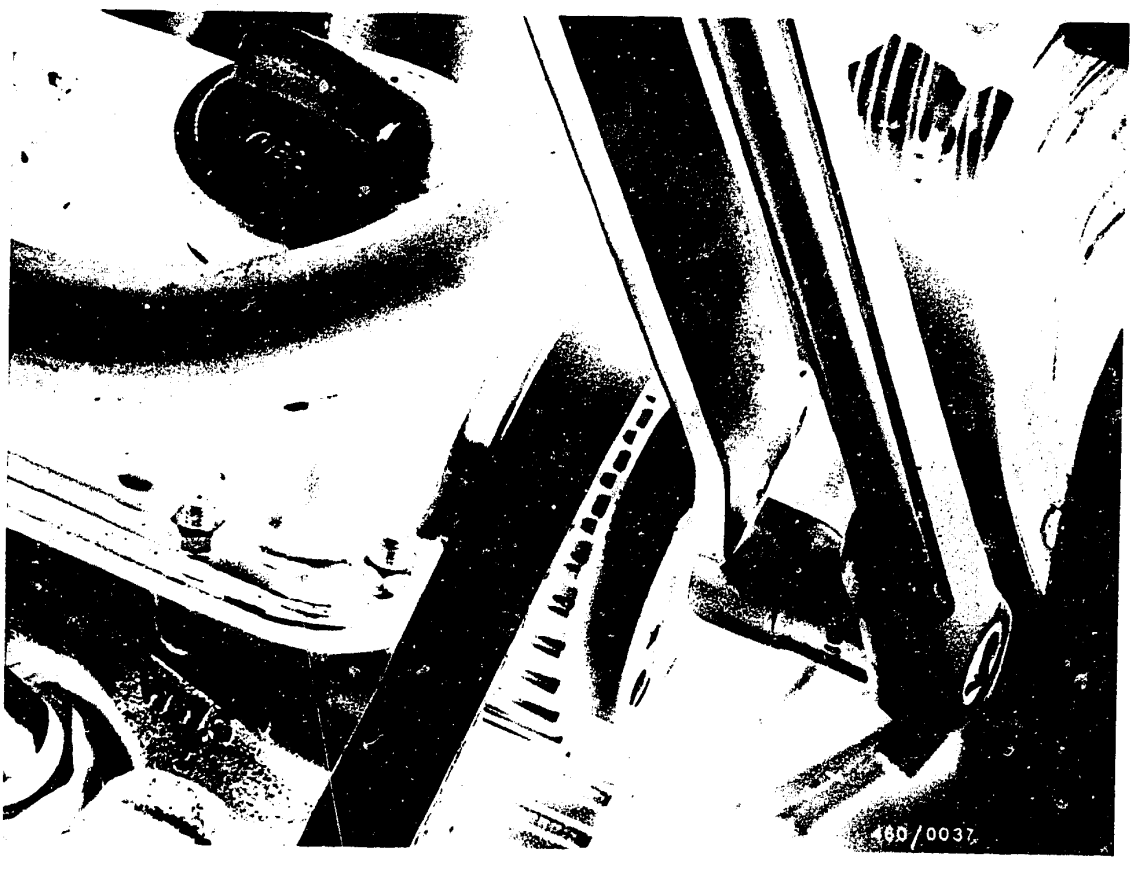


If the measured dimension differs from the set value, loosen fastening screws of pump bracket and of holding bracket on hydraulic head.

Move injection pump with bracket up or down as required (arrows).

Tighten fastening screws of pump bracket and of holding bracket to 65 Nm.

Turn engine crankshaft over twice and check tension of toothed belt again.

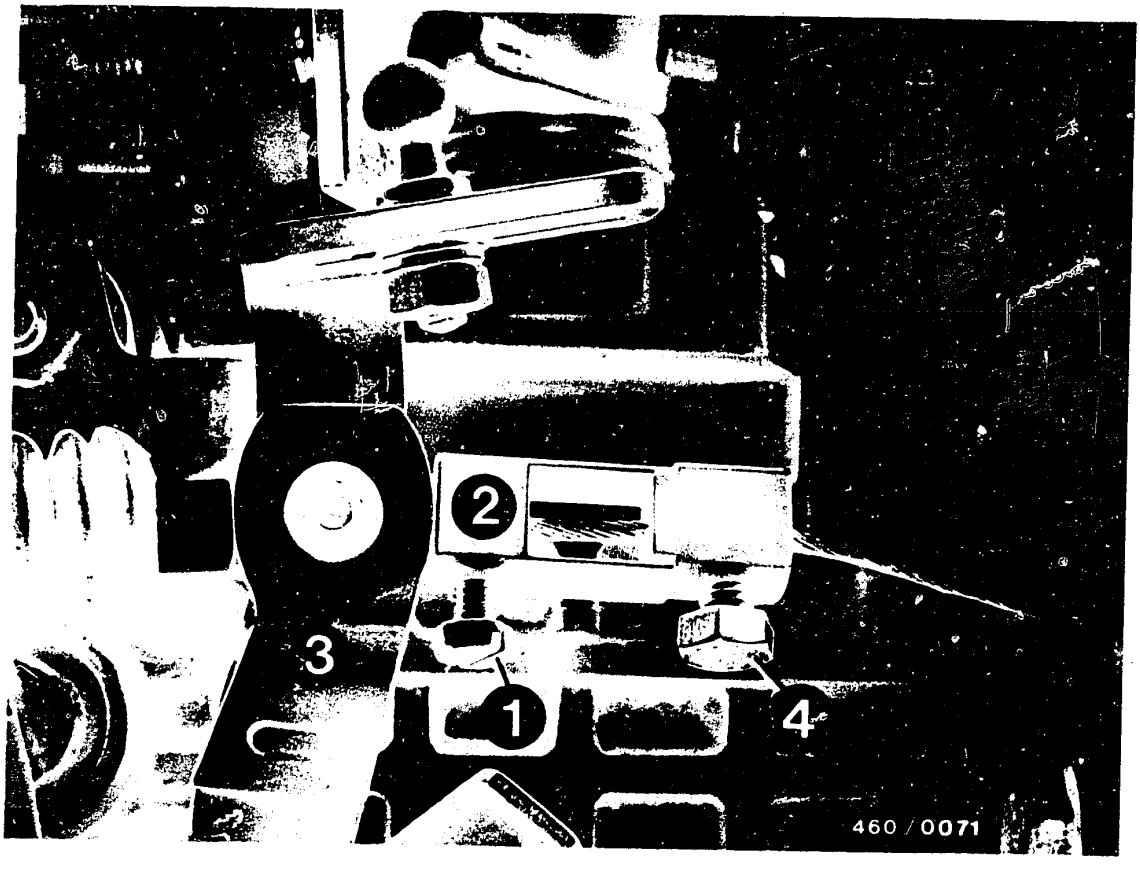


Test TDC position of crankshaft.

Lock injection-pump gear with setting mandrel KDEP 1122.

Hold camshaft gear with holder KDEP 1116 and tighten to 100 Nm.

Remove setting mandrel KDEP 1122.



When testing and adjusting the start of delivery, the temperature-controlled cold-start accelerator must be in the zero position.

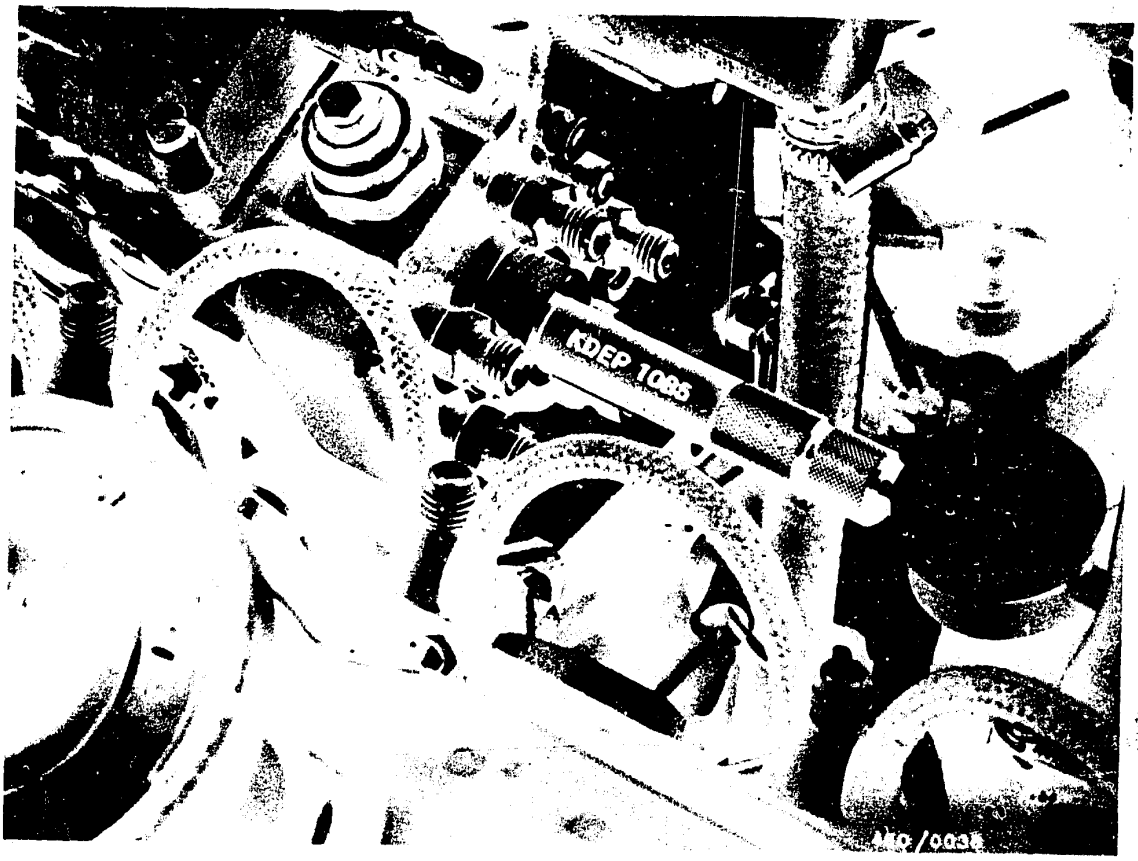
Loosen clamping screw (1) on injection pump.

Pull intermediate piece (2) with control lever (3) towards hydraulic head.

Turn intermediate piece (2) through 90° and push again toward drive shaft until control lever (3) is up against the stop bracket.

In this position, the control device is off.

Caution!
Locating screw (4) must not be loosened, since, otherwise, it will be necessary to reset the control device.



Remove injection lines from injection pump and nozzle holders (Prevent the delivery-valve holders from coming loose by holding with a wrench).

Unscrew bleeder screw out of central screw plug (traingular plug) of hydraulic head.

Mount measuring tool KDEP 1085 with dial indicator in tapped hole.

Preload dial indicator by approx. 2.5 mm

Slowly turn crankshaft against engine direction of rotation until the pointer of the dial indicator no longer moves.

Preload dial indicator by approx. 1 mm and set to "0".

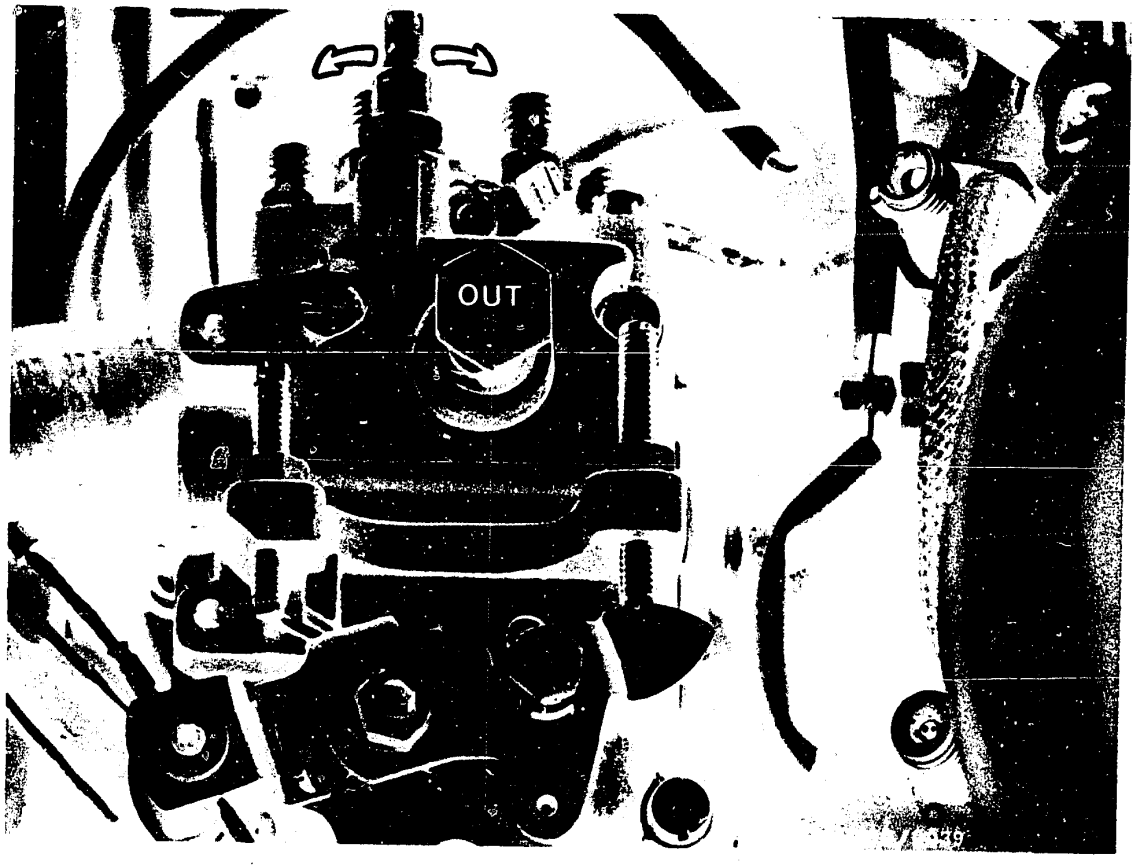
Turn crankshaft in engine direction of rotation until TDC mark on flywheel aligns with reference mark on clutch housing.

Check position of pump gear using setting mandrel KDEP 1122.

The dial indicator must show one of the following values as checking dimension.

Pump position 0.95...0.99 mm after BDC (9.78 - 11.82)

Pump position 0.78...0.82 mm after BDC (12.82 →)



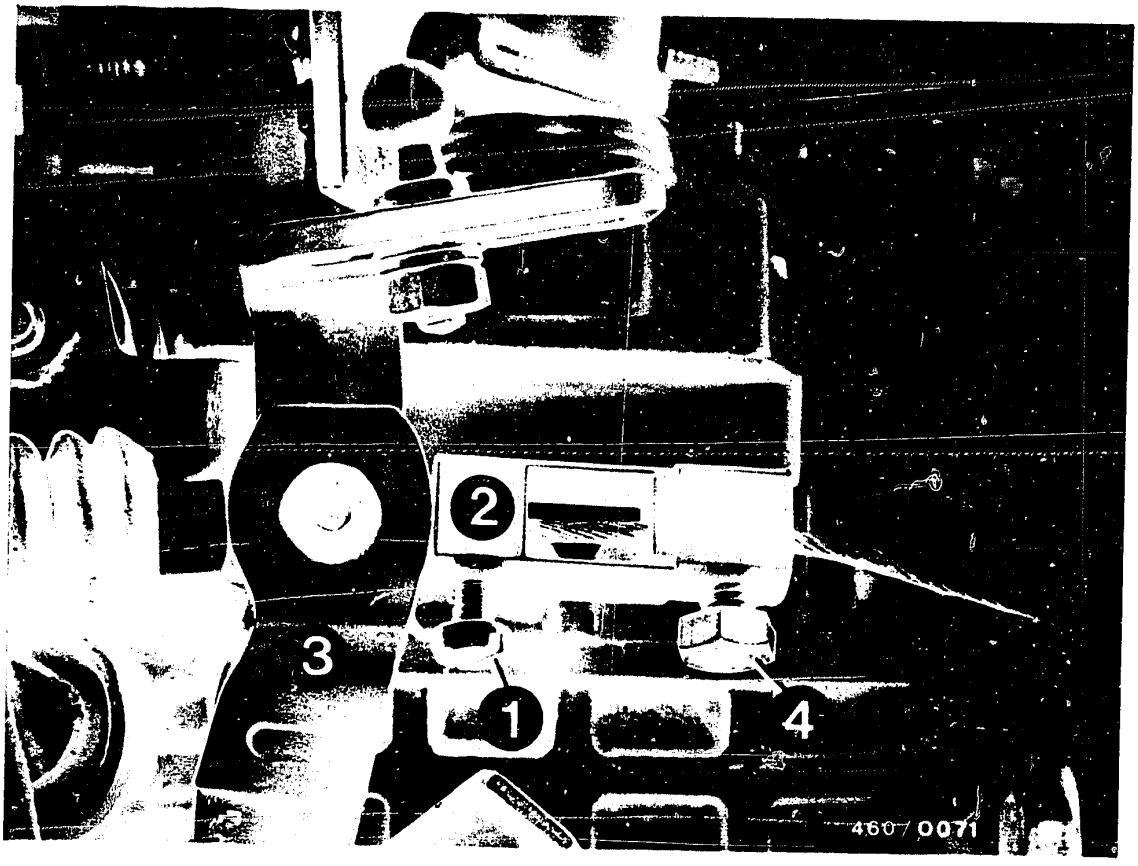
If a correction is necessary, loosen injection-pump fastening screws and set the respective stroke by pivoting.

Setting values:

Pump position 0.97 mm after BDC (9.78 - 11.82)

Pump position 0.80 mm after BDC (12.82 →)

Tighten fastening screws to 25 Nm.
Turn crankshaft over twice and check setting.



Pull control lever (3) with intermediate piece (2) toward hydraulic head.

Turn intermediate piece (2) through 90° and push again toward drive shaft.

Intermediate piece is in starting position.

Tighten clamping screw (1).

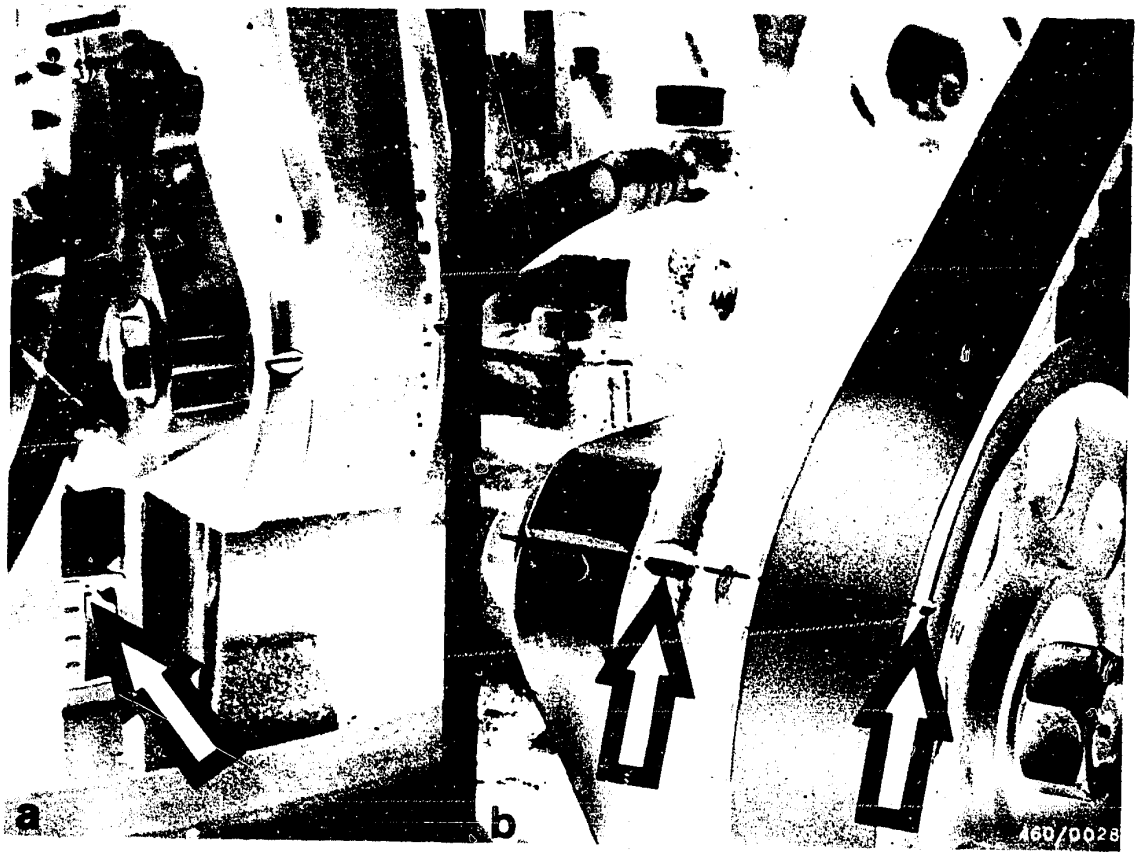
Caution!
Locating screw (4) must not be loosened, since, otherwise, it will be necessary to reset the control device.

Remove measuring tool KDEP 1085 with dial indicator.
Mount bleeder screw with new seal ring.

Mount toothed-belt cover.

Secure injection lines on delivery-valve holders of injection pump and on nozzle-holder assemblies (prevent delivery-valve holders from turning by holding with a wrench).

Mount air filter and expansion tank.



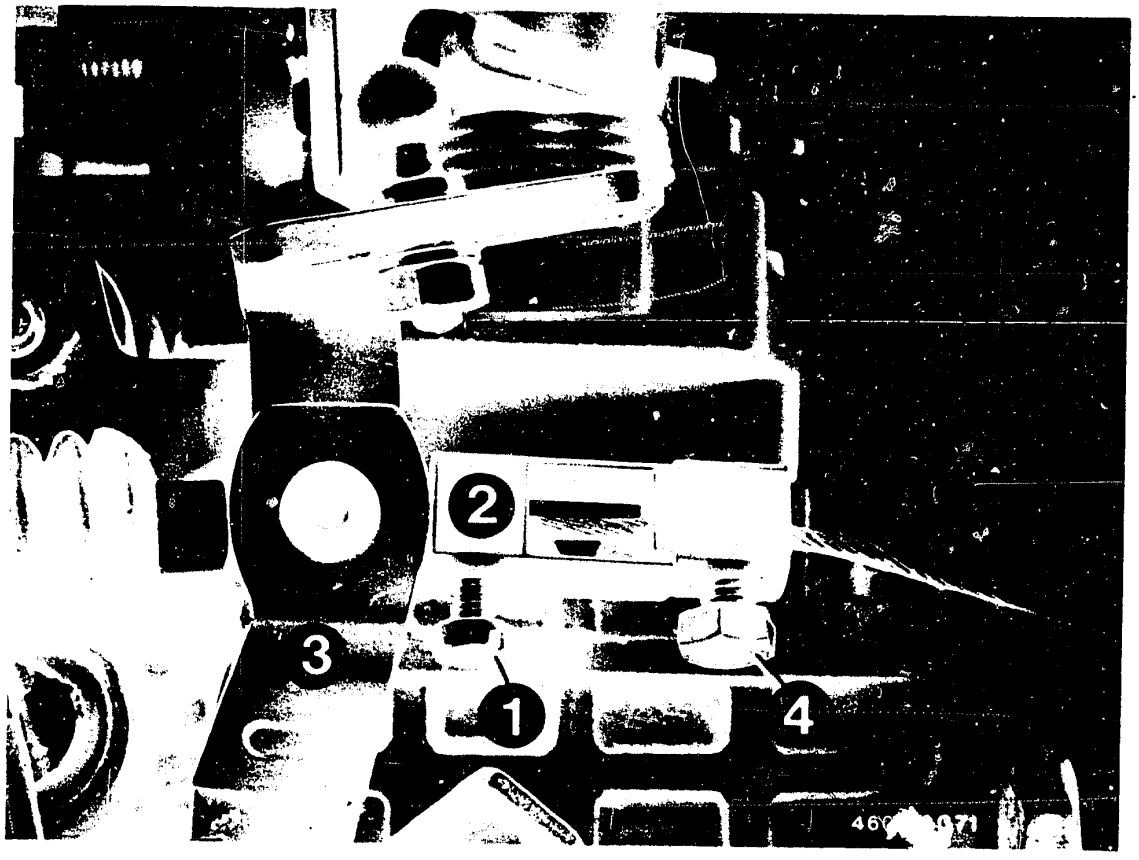
27. Injection timing

Remove coolant expansion tank and place to one side together with lines.

Remove air filter.
Remove toothed-belt guard for injection-pump drive.

Turn crankshaft to TDC on cylinder 1.

Marks on flywheel/clutch housing (Fig. a) and injection-pump gear/bracket (Fig. b) must be in alignment.



When testing and adjusting the start of delivery, the temperature-controlled cold-start accelerator must be in the zero position.

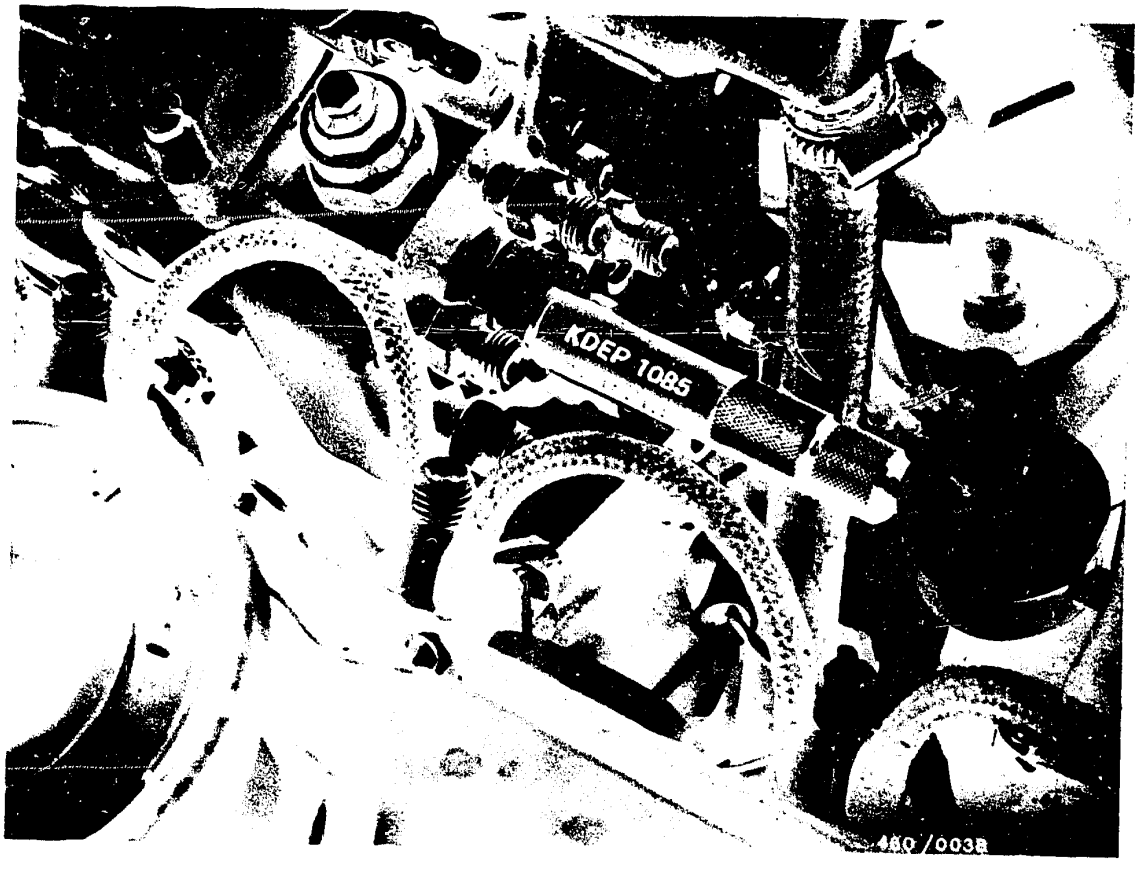
Loosen clamping screw (1) on injection pump.

Pull intermediate piece (2) with control lever (3) towards hydraulic head.

Turn intermediate piece (2) through 90° and push again toward drive shaft until control lever (3) is up against the stop bracket.

In this position, the control device is off.

Caution!
Locating screw (4) must not be loosened, since, otherwise, it will be necessary to reset the control device.



Remove injection lines from injection pump and nozzle holders (Prevent the delivery-valve holders from coming loose by holding with a wrench).

Unscrew bleeder screw out of central screw plug (traingular plug) of hydraulic head.

Mount measuring tool KDEP 1085 with dial indicator in tapped hole.

Preload dial indicator by approx. 2.5 mm

Slowly turn crankshaft against engine direction of rotation until the pointer of the dial indicator no longer moves.

Preload dial indicator by approx. 1 mm and set to "0".

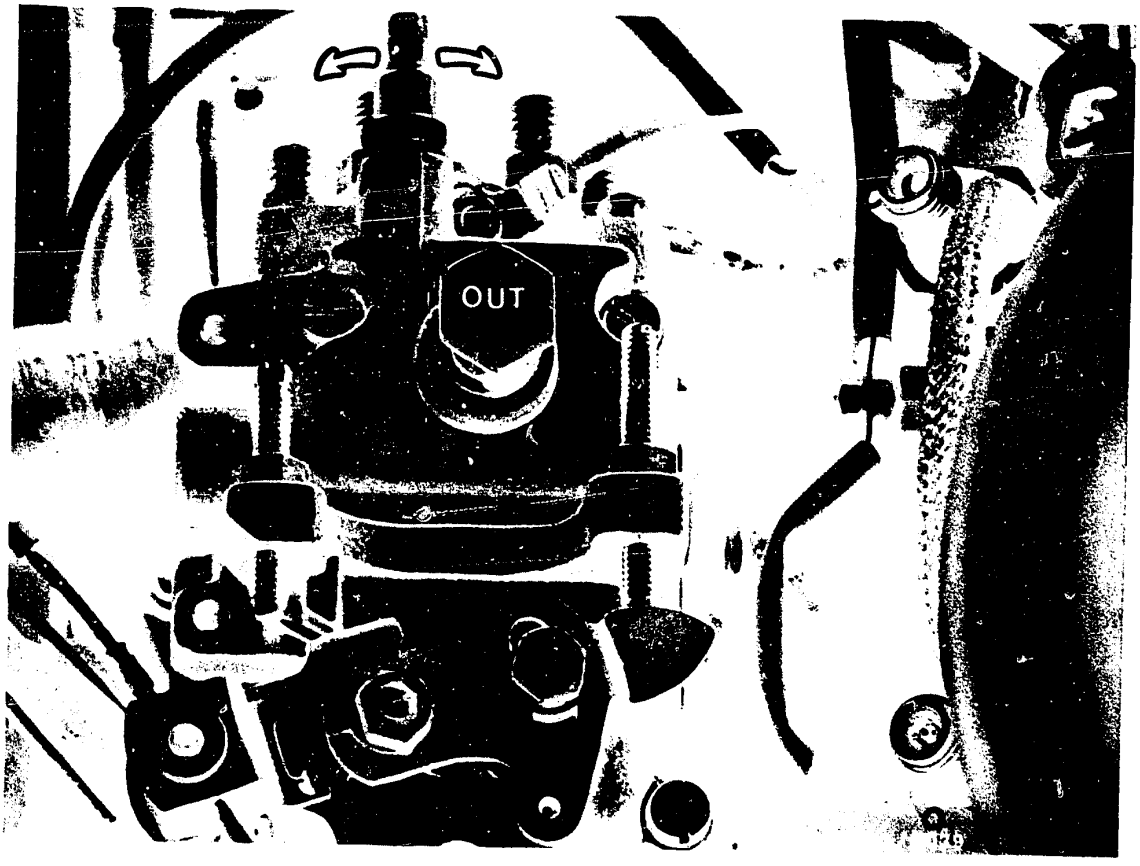
Turn crankshaft in engine direction of rotation until TDC mark on flywheel aligns with reference mark on clutch housing.

Check position of pump gear using setting mandrel KDEP 1122.

The dial indicator must show one of the following values as checking dimension.

Pump position 0.95...0.99 mm after BDC (9.78 - 11.82)

Pump position 0.78...0.82 mm after BDC (12.82 →)



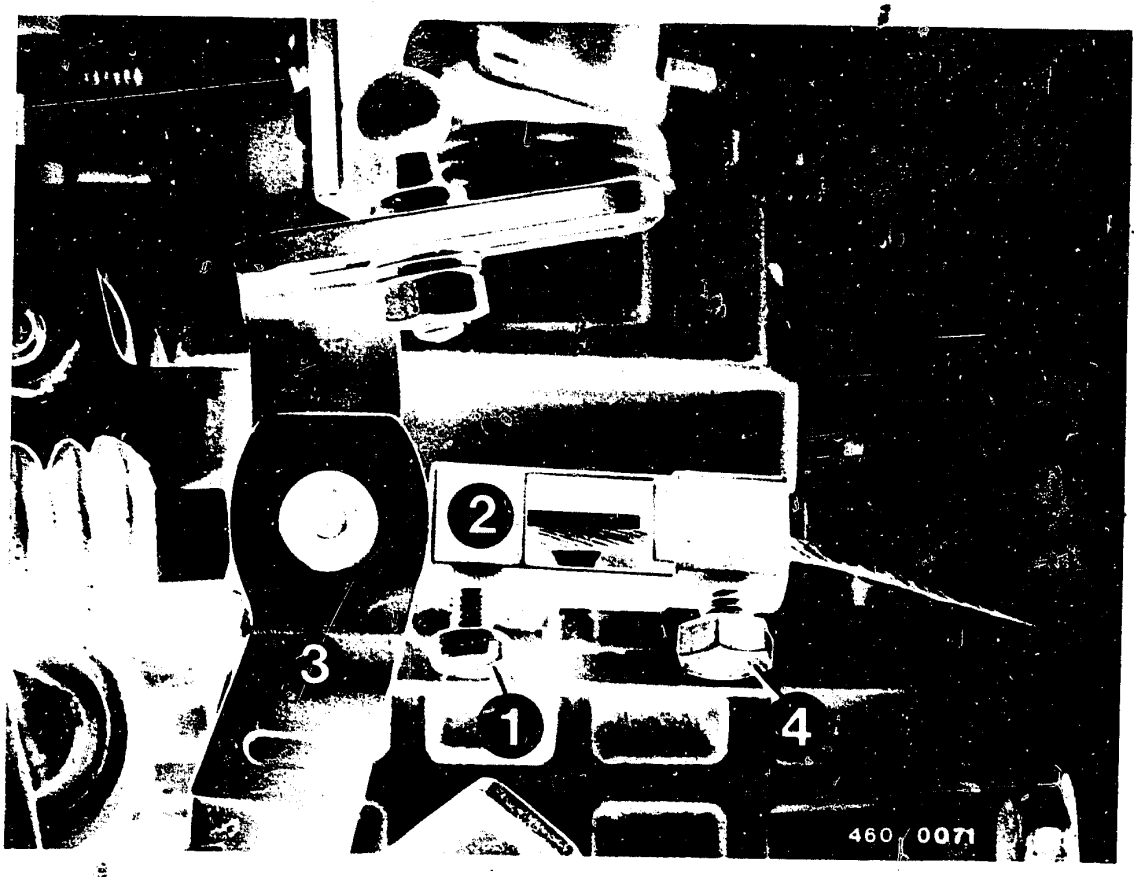
If a correction is necessary, loosen injection-pump fastening screws and set the respective stroke by pivoting.

Setting values:

Pump position 0.97 mm after BDC (9.78 - 11.82)

Pump position 0.80 mm after BDC (12.82 →)

Tighten fastening screws to 25 Nm.
Turn crankshaft over twice and check setting.



Pull control lever (3) with intermediate piece (2) toward hydraulic head.

Turn intermediate piece (2) through 90° and push again toward drive shaft.

Intermediate piece is in starting position.

Tighten clamping screw (1).

Caution!
Locating screw (4) must not be loosened, since, otherwise, it will be necessary to reset the control device.

Remove measuring tool KDEP 1085 with dial indicator.

Screw in bleeder screw with new seal ring.

Mount toothed-belt cover.

Secure injection lines on delivery-valve holders of injection pump and on nozzle-holder assemblies (prevent delivery-valve holders from turning by holding with a wrench).

Mount air filter and expansion tank.

TABLE OF CONTENTS

Table of contents (continued)

Automotive Equipment - After-Sales Service
Department for Technical Publications KH/VDT,
Postfach 50, D-7000 Stuttgart 1

Published by: After-Sales Service Department for Training and Technology (KH/VSK). Press date: 3.84
Please direct questions and comments concerning the contents to our authorized representative in your country.